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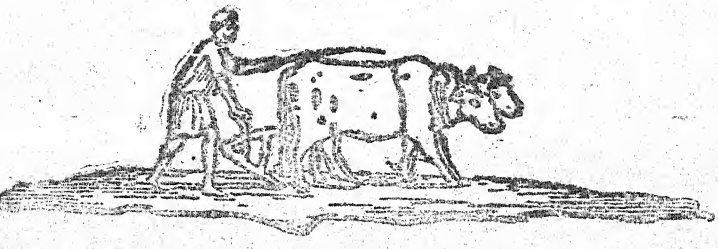

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A SURVEY OF THE SMALL TOOLS AND IMPLEMENTS USED BY FARMERS IN THE UNITED PROVINCES OF THE INDIA UNION.

Introduction.—This study was undertaken as the result of a suggestion from Prof. J. Lossing Buck of the Food and Agriculture Organisation, of the United Nations Organisation and was made possible by a grant from that organisation to cover expenses.

So far as the author knows, no comparable survey has as yet been made of the implements and machines used in agricultural production in the whole of pre-partition India. Many economic surveys of village life have been made but so far as is known, none of them has given any particular attention to the tools and implements used in agricultural production. Many efforts have been made to introduce improved implements, particularly improved plows. So far as the author knows, none of these efforts have been based on a survey of what the farmer now has to work with.

The survey was carried out during the period of July to December, 1947 which included the period when power was handed over by the former British Government to an all-India Government and the partition of the former India into the India Union and Pakistan.

India is a predominantly agricultural nation, with an economy based on small holdings, most of which are split into a number of non-contiguous fields. Implements and tools

used are primitive, little changed since ancient times and largely made of wood. Most of the implements and tools used are made by local caste workmen, rarely in a factory or by the farmer himself. The ancient village was self contained and aimed at self sufficiency. This pattern has been disturbed by the coming of factory manufacture of many things, particularly cloth, sugar, soap and many other articles of common use. The village life is feeling the impact of the machine age for instance in the coming of engine or electric-driven grist mills which for a small sum grind the meal used for bread, where formerly it was ground daily in the home with hand-powered stone mills.

The recent food shortage during and following the war has profoundly stirred leaders and people alike with the consciousnes of the need for profoundly changing the methods of agricultural production to get a greatly increased amount of food if famine is to be averted. This has focussed attention on the equipment with which the farmer wroks, how efficient it is and what can be done to improve it. There is a current demand for the introduction of the big machinary of the west and for the change in social and political organisation needed for such introduction.

Author's Acknowledgments.—The author wishes to express his appreciation to Prof. J. Lossing Buck, Head, Land Use Branch, Agriculture Division, Food and Agriculture Organisation, who made this study possible and who gave such help as was possible in planning it. Dr. A. T. Mosher, Head of the Extension Department of the Institute, and Mr. H. S. Azariah, Head of the Agricultural Economics Department of the Institute, kindly looked over the questionnaire and made useful suggestions. The actual survey was carried out by Messrs. C. S. Iyer, U. S. Lal, V. S. Saxena and Kailash Chandra. Mr. Iyer was largely responsible for the initial preparation of the questionnaire, with some assistance from Mr. Lal, and for the initial trying of it out. Mr. Lall was largely responsible for the tabulation of the data, and for much of its interpretation. Mr. Iyer devoted considerable of his time to checking of sheets as they came in and to general assistance in the conduct of the survey.

Purpose of the survey.—While there is a fairly extensive literature on agriculture and on rural life in India, written in English, there is very little of it which deals directly with the tools and implements with which the farmer carries out his work. The little literature there is, deals mostly with indivi-

dual improved or so-called improved implements or with tests of individual implements. Much more attention has been given in the past to such things as improved varieties of crops, manuring and pests and diseases. Many agricultural scientists in the colleges and the experiment stations are hardly at all acquainted with implements and their working and still accept that it is not possible to get along without the ancient implements or to work entirely with improved implements of any one type even. The subject of the implements with which the farmer works is largely ignored by most workers in improved agriculture.

The original suggestion for the survey was a part of the program to gather similar information from all over the world by F.A.O. It was welcome in India as an opportunity to get more exact factual information than was previously available about the implements actually used, their source, life, cost, and efficiency in work.

The survey was therefore undertaken for the following purposes :

(1) To obtain reliable information as to the implements now used, their frequency of occurence, ownership, period of year when used, life, cost (pre-war and present).

(2) To try to get at least preliminary information about the efficiency of the implements in use, their demand for human labor and the possibility of introducing improved variations of important implements.

(3) To try to discover some at least of the important problems concerning tools and implements which face the farmer at this time.

(4) To establish a pattern or method of study of the tool and implement problems of Indian farmers which might stir interest and help other workers to carry out similar studies in other parts of India and also to carry out more extensive and more intensive studies of these problems.

The time, funds and previous experience and knowledge of the organisers of this survey all limited the scope it could cover, both as to area and as to intensity. The actual work done dealt mainly with the first of these purposes. Some of the data bears on the second and third. How far the 4th will be accomplished will be decided in the future.

Method of study.—The information in this study was secured by 4 field workers as mentioned above. Mr. Iyer and Mr. Lal were recent graduates in both agriculture and agricultural engineering with some background of agricultural experience. Mr. Saxena had just completed the degree in Agriculture. Mr. Chandra had just completed the degree in agricultural engineering. All were native to North India and familiar with local dialects. Mr. Iyer devoted only part time to the survey and worked in the immediate vicinity of the Agricultural Institute, near Allahabad. This accounts for the smaller number of farms surveyed by him. Table No. I shows the areas in which each worked and the period of actual field work.

TABLE 1.

Sources of Data by Localities of United Provinces, time for which Data were obtained, number of Farms Studied and the names of Investigators.

Localities of United Provinces in which studies were made	Time to which data pertain	Number of Farms studied	Names of investigators
	1947		
Moradabad Region ..	15th Aug —Nov. 15th ..	40	Mr. U S Lal.
Partabgarh Region	15th Aug —Nov. 10th ..	40	Mr. V. S. Saxena.
Allahabad Region ..	15th Aug.—Sep. 30th ..	27	Mr. C. S. Iyer.
Gorakhpur Region ..	15th Aug —Nov. 20th ..	40	Mr. K. Chandra.
Total ..		147	

The survey was hampered by the lack of either experience on the part of anyone connected with or adequate literature on such surveys. Only when the survey was practically completed were we able to get a copy of Ogden King's study of "Farm Implements in Central China" in typescript and without the figures of illustrations. In addition to his lack of experience the writer had to add the duties of the survey to an already full program and could not devote the time which it would have been desirable for him to devote to it. None of the field workers had had experience with the field work of such surveys.

After consultations between members of the Agricultural Engineering, Agricultural Economics and Extension Departments of the Institute, Mr. Iyer prepared a field schedule of question covering 11 pages. This was tested by Mr. Iyer and Mr. Lal and such changes as were indicated were made before a larger number was duplicated. Since the investigators were all educated in English, it was more convenient to have this schedule in English. The individual farmers interviewed were for the most part illiterate, and the schedules had to be filled in by the investigators. The field workers were instructed in how to use the survey schedule.

Aside from the studies made near Allahabad, the three areas selected were chosen partly because of a desire to make the survey somewhat representative of the middle part of the Indo-Gangetic plain of North India and partly because of the possibility of making local contacts in these places. The Indian farmer is intensely attached to his land and suspicious of anyone who asks too many questions. He fears that the information may be wanted either for taxation or for the acquisition of land for other purposes. Even in areas where the investigator was known or when he was vouched for by locally prominent persons, it was often impossible to overcome this suspicion and it was necessary to abandon some villages where investigation were started because of this. The usual suspicion was intensified by the generally disturbed condition of the country incident to the transfer of power, the communal riots and the widely stated intention of the new government to foster co-operative and collective farming. Mr. Lal was therefore assigned to the area around his home where his family are land holders. Partabgarh and Gorakhpur are places where regional Agricultural Department offices are located and at Gorakhpur much of the information was secured in or with the help of residents of a Christian agricultural colony.

Another difficulty arose in selecting the farms to be surveyed. Especially near large cities, but even in small places, there is a surprising amount of part time farming. The caste system leads to a very high degree of specialisation and to the doing of many things *outside* the home which are normally done *in the home* in the west. Primitive sanitary arrangements require the daily cleaning of latrines, several times a day; the ordinary home has no sewing machine and all clothing is made by tailors; no home has even ordinary tools and all adjustments practically, at least all requiring

tools, are made by the village smith-carpenter who may be a part time farmer as well; some farmers also operate ox-carts for hire; others operate passenger vehicles for hire, attending to farming operations early or late in the day or seasonally; others are employed as laborers in various capacities. An attempt was made to survey only farms where the farmer derived 30% or more of his income from the land.

The areas to be surveyed were selected to lie 10 miles or more from a large town to minimise urban influence on employment. This was not true of Allahabad entirely as some schedules were filled for farmers some 3 to 4 miles from the city. In general, villages or groups of villages within a radius of 2 to 3 miles and a mile or two away from a main or trunk road were selected as being as nearly as possible representative of general average conditions.

The length of the schedule was another difficulty. It was rarely possible to fill in the whole schedule at one sitting. The farmer had, with a single exception reported, no records to refer to and had to depend entirely on memory. Some things he could recall clearly, some were hasy or forgotten, and guesses likely to be inaccurate. Writing the answers in front of the farmer was also in some cases an added reason for suspicion. It was necessary to get the whole of the information in several visits which slowed the process and limited the number of farms which could be surveyed in the allotted time of three months in the field.

The necessity of covering information for a whole year in a few visits over a period of only a few days undoubtedly introduces some errors. It is felt that a survey conducted by stationing a man in an area and having him make his own record of the information covered by the survey through a whole year on as many farms as he could cover would give a much more accurate picture of the actual operations performed and of the farm management phases of the enquiry. It would be desirable to have such a survey record made in the future for the additional information it would give which could not be covered by the survey under report.

It was not possible to give the field survey men any lengthy training. They all came to Allahabad and spent a couple of days going over the schedule and consulting and were instructed as to what they were to do and procedures. Each was given a set of written instructions

It was not possible for the director to visit the men in the field but they each came in for at least one short period of conference and discussion of their difficulties. They sent in their schedules in small batches as they were completed so they could be checked and difficulties noted.

Each man was furnished film for a number of exposures and asked to get pictures of the implements found. Unfortunately, due to lack of experience, they failed to follow instructions about backgrounds sufficientlly carefuly to get really usable pictures suitable for printing. The pictures taken were filed for reference.

Localities studied.—The general area selected for the study was the central part of the Northern half of the Indo-Gangetic Plain, the great area of densely populated alluvium stretching across North India. Table II gives the names of the villages from which data was secured and the number of farms in each that were studied.

TABLE II.

Sources of data by villages.

Regions of U. P. where studies were made	Names of villages surveyed	Number of farms included in the study	
Moradabad Region ..	Hathipur	15	
	Dhumnagar ..	8	
	Milak	8	
	Saraitrein	1	
	Deora	6	
	Chadupura ..	2	
			40
Partabgarh Region ..	Bhogapur	20	
	Gajrahi .. .	7	
	Chamroopur ..	1	
	Tilyahi	12	
			40
Allahabad Region ..	Mannakapurwa ..	6	
	Dabhaon	11	
1280	Dandi	10	
			27
Gorakhpur Region ..	Bishanpura . ..	4	
	Singheria	11	
	Barathpur	25	
			40
	Total ..		147

The soils and crops throughout this area are similar but one or another crop predominates in certain areas. Sugar cane is an important crop, both for mill crushing and for the home preparation of crude sugar in both Moradabad and Gorakhpur. Wheat is an important crop in all four areas. Table No. III indicates the number of farms in each area where each of the crops mentioned occupied 20% or more of the total area.

TABLE III.

Farms study in relation to crop regions.

*Crop Regions	Regions of U. P. in which studies were made	Number of farms	
Sugarcane Region ..	Near Moradabad ..	29	
	„ Gorakhpur ..	5	
			34
Wheat Region	Near Moradabad ..	11	
	„ Partabgarh ..	5	
	„ Allahabad ..	19	
	„ Gorakhpur ..	18	
			53
Barley Region	Near Partabgarh ..	21	
	„ Allahabad ..	22	
	„ Gorakhpur ..	3	
			46
Paddy Region	Near Gorakhpur ..	14	
			14
	Total ..		147

Study, Tabulation and Checking of Records.—As the sheets of completed schedules came in from the different field workers, Mr. Iyer checked through them to detect errors or omissions and began the study of them. At the end of the field study, Mr. Iyer worked for some time and Mr. Lal worked till December 20, tabulating and studying the records. The tabulation and checking was all done by hand as there were no facilities for any machine tabulation or checking.

Scope of study.—It was obviously not possible to study in a short period of 3 to 4 months and with the limited funds

*Crop Regions are divided on the basis of crops using 20% or more of the farm labour.

available, the whole of India. It was not possible to study even the whole of the United Provinces, where the study was located. The Province includes mountain region on the north, the great central plains region and an area of residual soil on hills to the south. The area of the Province is 112,523 square miles and the population is by the last census (1941) 56, 346, 456 giving a density of 500·7 per square mile. The area studied is perhaps the most thickly populated in the province and is near the highest in all India or in the world.

It was not poosible to study exhaustively all phases of the agricluture of the farms surveyed. When it was too late to rectify, it was noticed that no record was taken of the irrigation appliances on the farms studied, special sugar cane equipment like crushers, boiling pans, etc., were also omitted. It would have been interesting to get information about household furniture and equipment, more details of the source of implements and of methods of repairing them.

As the study was to be one of *small* implements and tools, little or no information was secured to make comparison with power operated implements. Aside from possible engine-driven irrigation pumps or power-driven cane crushers, no mechanical power is used by the farmers of this area so there was little material for comparison of animal-drawn and power implement costs. The few tractors with their implements used in the area are practically all on large farms operated by sugar mills or by large landlords. No data was secured on such cultivation in the course of the study. A discussion of the problem of mechanising Indian agriculture will be appended as an appendix to this report.

The Agriculture of the Area.—The area studied was the central part of the Northern part of the Indo-Gangetic plain which stretches all the way across North India. It lies just outisde the tropics in the southern edge of the temperate zone. The climate is very hot in the summer, mild in the winter with some frost but no freezing of the ground at any time in any part of the area studied. The temperature normally goes to 112° to 115°F during the hot weather of May and June and may go as low as 38° or so in the winter nights. Ranifall is mainly concentrated into the months of July, August, and September, with occasional light showers during other months, averaging some 2" during the 9 dry months. The monsoon rain varies from 35" to 45" in the area. With the exception of sugarcane, little is grown during the spring

and dry summer months. Where canal irrigation is available, some fodder, melons, curcubits and occasional other crops may be grown.

Due mainly to lack of fertility but also to lack of water outside the canal irrigated area, usually only 1 crop is grown yearly on most land. A little of the richest land is double crop and occasional catch crops are grown; after rice, for instance, peas may follow. Rice is grown mainly in the rainy season. For other crops, rather less than half the land is sown to the rainy season crop and rather more than half to the winter crop. In the rains, millets and pulses are the main crops, in the winter, the small grains with some pulses predominate. Table No. IV shows the importance of the 15 most common crops as indicated by area occupied in the different districts.

TABLE IV.

Important Crops Ranked by Proportion of Crop Area Occupied.

Regions studied	† Wheat	Paddy	Sugar cane	†Barley	†Gram	†Juar	†Bajra	†Urad	†Til	†Arhar	†Mustard	†Linseed	†Cotton	†Sanai	†Sawan
Moradabad Region.	*2	10	1	4	6	3	5	9	7	12	8	15	14	13	11
Partabgarh Region.		7	..	1	5	3	4	..	..	8	..	..	..	6	..
Allahabad Region.	2	8	..	1	5	3	4	12	13	6	11	7	..	9	10
Gorakhpur	2	1	8	3	5	7	6	14	12	4	9	10	..	13	11

* The numerals represent the order of importance, one being the greatest area, two the second greatest, and so on.

†These crops are sown as mixed crops with other crops.

TABLE No. V.

Average size of holdings in U. P.

Serial No.	District	Average Size of Tenants Holding (Acres)	Average of the District (Acres)	Average of the five Districts (Acres)
	I—SUBMONTANE			
1	Pilibhit	6·5		
2	Kheri	6·8		
3	Sitapur	6·8		
4	Bahraich	6·6		
5	Gonda	5·3		
6	Basti	4·0		
7	Gorakhpur	4·1	5·7	
	II—UPPER DOAB			
1	Saharanpur	10·4		
2	Bijnor	9·1		
3	Moradabad	6·7		
4	Muzaffarnagar.. ..	11·5		
5	Meerut	8·7		
6	Bulandshahr	7·9		
7	Aligarh	9·8		
8	Muttra	10·3		
9	Agra	7·6	9·1	
	III—CENTRAL DOAB			
1	Bareilly	5·3		
2	Budaun	5·7		
3	Etah	6·5		
4	Mainpuri	5·9		
5	Shahjahanpur	5·7		

Serial No.	District	Average Size of Tenants Holding (Acres)	Average of the District (Acres)	Average of the five Districts (Acres)
6	Farrukhabad	5·3		
7	Etawah	6·0		
8	Hardoi	5·6		
9	Unao	4 7		
10	Cawnpore (Kanpur) ..	6·3		
11	Lucknow	4·9		
12	Barabanki	4·8		
13	Rai Bareli	4·5		
14	Fatehpur	6·6	5·5	
	IV—EASTERN DOAB			
1	Fyzabad	4·2		
2	Sultanpur	4·2		
3	Partabgarh	4·0		
4	Allahabad	5·7		
5	Azamgarh	3·4		
6	Jaunpur	3·5		
7	Benares	4·6		
8	Ghazipur	4 9		
9	Ballia	5·1	4·4	
	V—TRANS JUMNA			
1	Jhansi	11·7		
2	Jalaun	12·4		
3	Hamirpur	11·9		
4	Banda	10·9		
5	Mirzapore	5 0	10·4	7·02

The common pattern of cultivation is the small individual holding, consisting of several, usually about 5, fields scattered about the village area, no two adjoining. The common thing in the area studied is for all residences and cattle shelters to be grouped into one village, often with the quarters occupied by the village menials or low caste laborers either on one edge or in a slightly separated hamlet. Individual residence on the holding are unusual, if not entirely unknown, in most of the area.

The average area of the holding in the United Provinces as a whole is small as shown by the following table taken from the Diary published by the Government Agricultural College, Kanpur 1943. (Table V on page 471—472).

The figures in the above table are probably slightly low because they include all holdings registered as such, without regard to whether they represent farm enterprises which support a family or not.

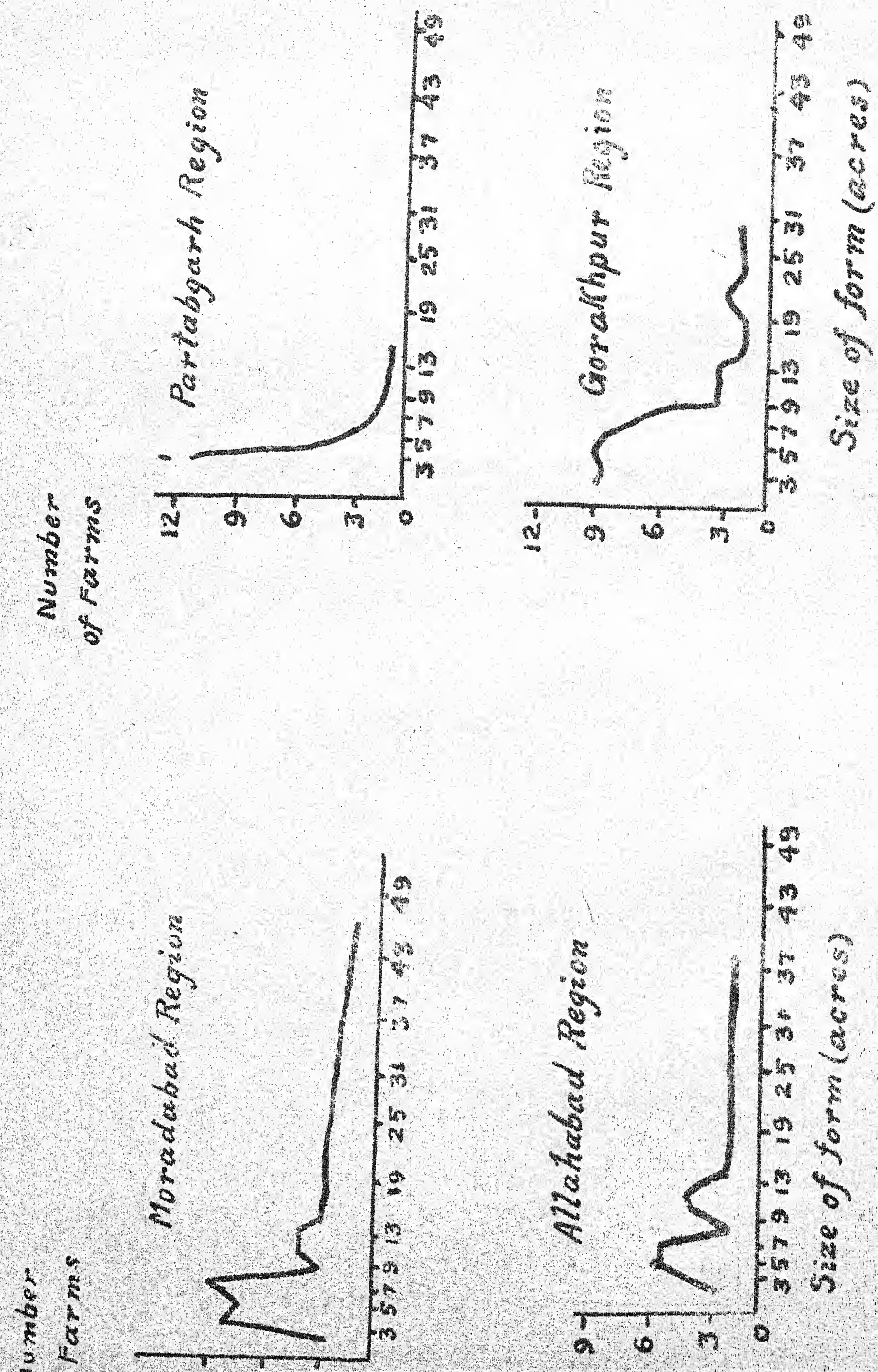
The frequency distribution of the farms surveyed was worked out by areas at intervals of two acres as shown in Table No. VI.

TABLE VI.

Frequency distribution of size of farm areas.

*Interval class	Number of farms in each class of two acres interval				Total
	Moradabad Region	Partabgarh Region	Allahabad Region	Gorakhpur Region	
1 ..	2	..	1	..	3
3 ..	8	25	3	9	45
5 ..	7	7	5	10	29
7 ..	9	3	5	9	26
9 ..	2	3	1	..	5

* The interval class is designated by the mid-point; for instance, 1 is the midpoint of of the 0-1-9 interval, 3 is the midpoint of the 2-3·9, and so on.


Number of Farms
Partabgarh Region
Gorakhpur Region
Size of form (acres)
Number of Farms
Moradabad Region
Allahabad Region
Size of form (acres)
0
3
6
9
12
3 5 7 9 13 19 25 31 37 43 49

*Interval class		Number of farms in each class of two acres interval				Total
		Moradabad Region	Partabgarh Region	Allahabad Region	Gorakhpur Region	
11	..	4	1	3	2	10
13	..	4	1	4	2	11
15	..	3	1	1	2	7
17	..	..	..	..	1	1
19	..	..	..	1	1	2
21	..	..	..	1	2	3
23	..	..	..	..	..	..
25	..	..	..	1	1	2
27	..	..	..	..	..	..
29	..	..	..	..	..	..
31	..	..	..	..	1	1
33	..	..	..	..	..	..
35	..	..	..	..	..	..
37	..	..	..	..	..	—
39	..	..	..	1	..	1
41	..	..	..	..	..	..
43	..	..	..	..	..	..
45	..	..	..	..	..	..
47	..	1	..	..	..	1
49	..	..	..	..	..	..
51	..	..	..		..	..
Total		40	40	27	40	147

Frequency distribution of farm areas in acres for 147 farms in four regions of U. P.—It will be noted that 3 of the 147, or 2% were less than 2 acres. These were most likely part time farms which barely got under the requirement of percentage contribution to total income. 32·65% or 48 were less than 4 acres in area. 77 or 52·38% were less than 6 acres. 103, or 70% were less than 8 acres in area. 129 or 87% were less than 14 acres. 136 or 92·5% were less than 18 acres. Only 11 of the 147 were 16 acres or larger.

Unfortunately no record was kept of the point but is probable that the larger part of the farms of more than 8 or 10 acres represent undivided joint family holdings where more than one "family" in the Western use of the word work together. Often when a holding is close to a city, say within even 10 or 12 miles, one or more of the brothers in such a family will work in the city, cycling back and forth, while the other or others, sometimes with the father, will continue to work the family land as a joint enterprise. The one working outside contributes cash, the others food, to the joint needs of all. This often extends to some members going long distances, even several hundred miles, to one of the manufacturing or port cities to work, leaving his family in the ancestral home and sending back cash contributions.

Whereas the distribution or average size of holdings shown in Table No. VI is probably too small, it is likely that the field surveyors tended to choose larger farms than the average for study. Usually-not always—it is the more openminded, more intelligent hard working person who has the larger holding. Such a person is more likely to be cooperative, willing to give information and less prejudiced than the small holder.

When the questionnaire was made out, it did not occur to anyone to record the uncultivated area in a village. Farms as such or holdings are areas of cultivated land. There may or may not be undivided uncultivated areas in the village area. Mostly they are barren or unproductive areas and are usually claimed by the landlord. Nominally they are undivied grazing land and there have been tenant-landlord conflicts because of the landlord allowing tenants to plow up such land. Many villages no longer have any grazing land. The houses in the village are usually quite closely packed together and there may be little or no vacant land in the village not occupied by houses. This is not universally true as some villages are fairly open with fair sized courtyards to the houses and some open land between, often unculturable or unsuitable for building or in some cases occupied by trees or tanks.

Soil of the Area.—The soil throughout the area studied is an old alluvium, not subject to flooding in recent historic time. Typically it is a loam or sandy loam though areas of quite sandy soil and also of fairly heavy clay do occur. The importance of rice indicates heavier soil in the Gorakhpur area than in the other areas.

Though the soil is old alluvium, there is little evidence of weathering into surface soil and subsoil. There is considerable stratification, with layers of sand, clay, silt, and mixtures alternating in varying patterns. In many areas lime concretions (locally called "kankar") occur sometimes as individual pieces varying from small gravel to large pieces; in other places, solidified beds of lime concretions occur, sometimes several feet thick and often quite hard. Over large areas these are the only locally available road metal and they also are burned into a sort of natural cement for building work. Where these beds occur near the surface, they may have the same effect as solid bedrock would have in making the soil unproductive.

Unproductive land generally is referred to locally as "usar". There has been a tendency to translate this as "alkali" though there is little true alkali land in the area. Occasional fields where the water is drained from surrounding areas and is impounded and allowed to evaporate do show definite alkali deposits. The ground water is highly charged with disolved mineral matter and where waterlogging occurs there is a tendency to build up alkali in the soil. However this is not a very serious proplem in the area of the United Provinces as yet. It is west in the Punjab and may become so with further extension of the intensive irrigation now advocated.

1880

One reason for the lack of dovelopment of clearly defined surface and subsoils is the general lack of organic matter. Most of the land has been cultivated or grazed intensively for centuries, giving little opportunity to build up organic matter as occurs in forest or ungrazed grass land. While growth is luxuriant during the rainy season, practically everything is removed for food, feed or fuel. Small grain and pulses are harvested right to the ground level. The larger crops like sorghums, millets or maize are cut low and the stubble subsequently removed, either for fuel or to clear the land for a subsequent crop. The wooden plow stirs the soil and has little tendency to bury organic matter. It does mix

into the surface well decomposed compost but tends to bring to the surface and expose any undecomposed material.

The second reason is that both the climate and the method of soil working are calculated to break down organic matter and have it disappear from the soil as fast as possible. Temperatures are suitable for bacterial activity practically throughout the year and moisture is favorable except in the summer months, of April, May and June. Even then, the heat seems to favor certain types of chemical change which may involve the breaking down of organic matter. The net result is that the amount of organic matter in the soil is a minimum which reacts on both the physical condition of the soil and on its fertility.

Water Supply.—The water supply is sufficient, usually abundant, during the three months of July, August and September. However, this is not consistently so. The most common pattern is a season of rain for a week or ten days, a break of ten days or so, then fairly constant regular rain till the end of August with again irregular, but usually sufficient, rain during September. There may or may not be showers in late October or early November. There is usually a period of cloudy weather and often light showers around Christmas. There are often a few showers in late March or early April. The monsoon rain in July, August and September may fail nearly all together, being as little as half the normal or even less. There may be rain in any or every month of the year. The rain from about the middle of September to the middle of June may vary from nothing at all to as much as ten inches, usually averaging about two inches at Allahabad.

Most of the Moradabad area and some of the Partabgarh area is served by canals. Irrigation wells, both of the ordinary dug type and of the tubewell type are possible anywhere in the area and are common. No data was secured on how much of the area covered by the farms surveyed is covered by irrigation, though this would be helpful in understanding the agriculture of the area. In general, moisture in the Gorakhpur area is more favorable than in the other areas and irrigation is less necessary. In all cases, irrigation is considered expensive and the agricultural practices are designed to do as much as possible without it.

Results of Implement Studies.—In the original schedule of questions, the following check list of implements was included for checking. Appendix No. I gives a short description of each tool or implement. (*Not included in this issue.*)

TABLE VII.

Number of implements with Local and English Names, in all the four Regions studied.

Serial no.	Implements owned: Local name	Implements owned: English name	Used for	Moradabad Region 40 farms	Partabgarh Region 40 farms	Allahabad Region 27 farms	Gorakhpur Region 40 farms	Total
1	Desi plough ..	Wooden plough ..	Ploughing, hoeing pulverization and harrowing of land	60	42	39	70	211
2	Improved plough	Moldborad plough	Ploughing, pulverization of land ..	20	..	2	39	61
3	Patela or Patelea	Clodcrusher-planker	Levelling and breaking of clods ..	36	42	15	53	146
4	Khurpi ..	Substitute for hoe	Weeding and interculture between crops.	142	123	126	210	601
5	Hansia ..	Sickle ..	Harvesting of crops	143	136	126	188	593
6	Gandasa ..	Chopper ..	Chopping fodder	92	47	41	125	305
7	Phavra	Spade-Heavy hoe	Digging the land and for making irrigation channels in fields.	50	63	31	125	269
8	Kassi ..	Pick like hoe ..	Interculture in sugarcane crop in gardens and orchards.	78	..	..	..	78
9	Kasla ..	Wide blade khurpi	Interculture in sugarcane crops before the plants come out, or when they are small.	118	..	..	..	118
10	Pancha ..	Wooden fork ..	Assembling feeds as bhusa etc., and the crop during threshing time.	46	5	..	3	54
11	Hathia ..	Wooden spoon for water.	During threshing period and irrigation time.	..	..	..	65	65
12	Aakhein ..	Crude pitch fork	For turning the threshed crop during threshing process.	..	..	..	76	76
13	Chaffcutter ..	..	Machine for chopping fodder ..	6	..	..	6	12
14	Cultivator ..	..	..	..	..	..	..	..
15	Winnower ..	..	..	..	..	..	..	..
	Acreage covered in different regions		.. .. ..	654·79	175·56	289·25	246·07	

Total acreage of 147 farms in all the regions = 1365·67 acres. Total number of implements in all regions = 2589

Table No. VII shows the implements and tools found in each of the four areas and the total number of each type in the four districts. Of these, all but two implements are traditional or old type implements. The two exceptions are the "improved" or "Mouldboard" plows and the chaff cutter. It may be noted that chaff cutters were found on 6 farms each in Moradabad and Gorakhpur areas. It was the same areas in which improved plows were found most commonly. Of the 40 farms studied in Moradabad, half of them on the average had an improved plow. On the 40 farms in Gorakhpur, there were 59 plows of improved type. This reflects largely the importance of certain cash crops grown, particularly sugarcane, which ranks first in importance in Moradabad and 8th in Gorakhpur. Soil turning plows have proven particularly important or valuable in sugarcane culture. The varieties now grown are newly introduced in the last two or three decades. One change in the crop grown has favorably disposed the farmers to another.

Another factor which may have affected the introduction of improved plows in the Gorakhpur area is the fact that many of the farms surveyed were in a Christian colony which was formed and settled only a generation or two back. The fact that the people concerned had broken with other customs and connections probably favorably disposed them to new implements also. Also sugarcane has an importance in the Gorakhpur district greater than is indicated by its importance shown by this survey.

Table No. VIII shows the number ofar mers in each area owing one or more of the old style implements or tools for which data was recorded. The wooden plow is almost universally owned by all farmers, only 1 each in Moradabad and Allahabad areas not having them.

TABLE No. VIII.

Old style implements used in all the four regions with relation to the number of farms owning them in each region.

Regions studied	Implements owned by the number of farmers											
	Wooden plough	Country harrow	Patela	Khurpi	Hansia	Gandasa	Phavra	Kassi	Kasla	Wooden fork	Hathia	Ankhein
Moradabad Region (out of 40 farmers)	39	..	29	40	40	40	22	34	26	29	..	..
Partabgarh Region (out of 40 farmers)	40	..	40	40	40	40	40	..	5	..	..	..
Allahabad Region (out of 27 farmers)	26	..	15	27	27	26	23	..	..	..	..	..
Gorakhpur Region (out of 40 farmers)	40	1	38	40	39	39	40	..	..	6	40	39
Total 147 farmers	145	1	102	147	146	145	125	34	31	38	40	39

The khurpi, hansia and gandasa are also nearly universally owned and used. The other tools vary much more from district to district, some being used only in one or the other locality and not elsewhere. The patela or drag or clodcrusher is also very widely used. It is probable that those not owning this item have arrangements to borrow or hire one from a neighbor. This is very common practice for the implements used only a few hours a year by any one farmer. The kassi is almost entirely a sugarcane inter-culturing tool so is used largely in those areas where sugarcane is the main, crop, little or not at all elsewhere.

Improved implements have not as yet secured a very firm foothold in any of the districts. When analysed by the farmers owning them, the position is different from that indicated by averages mentioned above. Table No. IX gives the number of farmers in each area owning one or more of the improved implements.

Prices of Implements.—The prices of implements and tools
general inflation that has taken place in the country. In
as they were 10 years previously. This relationship is shown

TABLE

Prices of the implements used in all the four regions

(A) Prices of

Regions studied	Wooden plough	Improved plough	Patela	Khurpi	Hans'a	Gandasa
Moradabad Region	10 0 0	12 0 0	8 0 0	1 0 0	2 0 0	2 0 0
Partabgarh Region	10 0 0	..	4 0 0	1 0 0	1 0 0	2 0 0
Allahabad Region.	8 8 0	..	6 8 0	1 0 0	1 4 0	1 8 0
Gorakhpur Region.	6 0 0	11 8 0	6 0 0	0 2 6	0 7 0	1 12 0
Average	8 10 0	11 12 0	6 2 0	0 12 6	0 14 9	1 13 0
						(B) Prices of
Moradabad Region.	2 8 0	5 0 0	2 0 0	0 3 0	0 4 0	0 8 0
Partabgarh Region.	4 0 0	..	2 0 0	0 4 0	0 4 0	0 12 0
Allahabad Region.	3 0 0	..	2 0 0	0 6 0	0 6 0	0 8 0
Gorakhpur Region.	2 12 0	5 0 0	1 8 0	0 0 9	0 2 6	0 12 0
Average	3 1 0	5 0 0	1 14 0	0 3 6	0 4 9	0 10 0

* Ankhein—Farmers make it out of a suitable branch of any tree

at the time of the survey and 10 years earlier reflect the general prices at present are 3 to 4 times as much in rupees in Table No. XI.

No. XI.

in the year 1947 *and* 1937 *in rupees, annas and pies.*

(1947)

Phavra	Kassi	Kasla	Wooden fork	Hathia	Ankhein*	Chaffcutter
5 0 0	3 0 0	0 14 0	1 0 0		..	100 0 0
6 0 0	..	..	0 12 0	..	..	..
3 0 0	..	..	..	..	..	..
3 8 0	..	..	..	1 8 0	..	..
4 6 0	3 0 0	0 14 0	0 14 0	1 8 0	..	100 0 0
(1937)						
1 0 0	0 12 0	0 3 0	0 4 0	..	..	29 0 0
2 0 0	..	..	0 3 0	.	..	..
0 14 0	..	..	..	..	..	..
1 4 0	..	..	..	0 6 0	0 4 0	..
1 4 6	0 12 0	0 3 0	0 3 6	0 6 0	..	29 0 0

and so the cost is almost nil.

While few if any farmers would have the whole list, for purposes of comparison a farmer could have gotton one each of the implements and tools listed at average prices for Rs. 13-13-6, excluding the chaff cutter and including it, for Rs. 42-13-6. In 1947, the same implements would have cost Rs. 37-8-9 and Rs. 127-8-9 respectively. This is an average increase of practically three times.

However, in terms of grain, the price of implements has not increased in anything like this proportion. Table No. XII on page 13A shows the relative prices of some of the more important crops ordinarily sold by the farmer to get cash for purchases.

TABLE No. XII

Crop	Whole sale prices per Maund	
	1937	1947
	Rs. a. p.	Rs. a. p.
Wheat	3 8 6	10 4 0
Rice	6 8 6	22 15 0
Potatoes	2 8 0	15 0 0
Linseed	4 14 0	22 6 0

The prices in the above table are the Government controlled rates in 1947 and of course the ordinary market rates in 1937. Actually, the control extended only to the cities and much of the grain market was not effectively controlled in 1947 so that the prices received by many farmers were considerably higher than the above, which would make the position more favourable. There was no rationing or control of implements and tools so the prices given in Table No. XI are actual prices in the market.

It may also be noted that the prices of improved implements did not change as much as did the prices of the ordinary country types and hand tools. This may reflect to some extent the fact that iron and steel were controlled and

rationed and that the prices of metals was not allowed to rise as much as the general inflation would have demanded. The smaller hand tools are largely made of scrap metal of one sort or another and this was not controlled so that the prices of these rose in sympathy with the general inflation of prices. Wood also was used very heavily for many purposes so that the supply became shorter even than usual and so the price rose, as well as wages.

From Table No. XIII it will be seen that most of the tools and implements used in India can be worked by one person. Because the questionnaire did not call for it, no mention was made of the use of the wooden plow for seeding purposes. For this, a pipe made of a bamboo is fitted at the back of the plow so that seed dropped into the top end are deposited just at the back of the plow as it works in the soil, the seed being covered by the soil falling back into the furrow behind the plow. The top of the bamboo spout has a funnel fitted of wood, clay or sometimes of the bamboo split and woven with other thin strips of bamboo to make a basket work funnel. The seed is dropped into the fuunel by hand. In the areas surveyed, the plow and oxen are handled by a man, the seed usually being dropped by a woman. In certain other areas notably in the part of the Punjab now included in Pakistan, one man alone often manages the whole arrangement, driving the animals by verbal command, handling the plow with one hand and dropping the seed with the other hand.

TABLE No. XIII

Type of power required for the operation of implements in all the four regions.

Regions studied	Kind of power needed for operation												
	Number of bullocks			Hand (man labour required)									
	Wooden plough	Improved plough	Patela	Khurpi	Hansia	Gandasa	Phavra	Kassi	Kasla	Wooden fork	Hathia	Ankhein	Chaffcutter
Moradabad Region. Partabgarh Region. Allahabad Region. Gorakhpur Region.	2 & 1 man	2 & man	2 & 1 man	1	1	1	1	1	1	1	1	1	1

While not brought out by the survey data, there is a tendency to use two men on improved implements especially those having two handles. The wooden plow has a single handle and generally the improved plows introduced have also been fitted with a single handle. Some of the larger sizes are difficult to control with one hand are and fitted with two handles and where the men have become accustomed to two handles, smaller ones are also being offered with two handles. Some of the larger sizes, particularly in heavy work require more than one pair of animals. Since in most places,'lines are not used to control the animals, in such cases a driver is used for each pair of animals. There is a tendency to carry this over to the working of all two handled implements such as the small cultivators (horse hoes) and small plows. Apparently there is a feeling that where handles are provided they must be held and that a man holding two handles has his hands full and cannot therefore control oxen. There is a strong disinclination, even where lines are used, to putting them round the shoulders and using them by occasional taking one hand from the implement to pull on a line. An extreme instance of the tendency was observed some years ago when some small five-row grain drills were imported. These had originally been designed for seeding winter wheat between standing rows of maize and for such use, required occasional steering. They were being used in India for seeding in open clear fields but, since the handles were there, they must be held and it proved to be impracticable to get the drills operated by single men. When the handles were removed, no further difficulty was experienced in getting one man to work a drill.

All bullock drawn implements used in North India for field work are designed for operation by *pairs* of implements. This may be because of the comparative ease of hitching with a yoke as compared to harness. Carts pulled by a single animal are fairly common on the roads but rare in field work and no other instance is known to the writer of single animal drawn implements that might be used for field work.

Except for one operation, the use of more than one team on an operation is uncommon in the area surveyed. The exception is in the use of the Patela or drag. Some of these are fairly long, as much as 10 to 12′. These are considered too heavy for one pair of animals so a pair is hitched to each end and each pair is driven by its own driver.

Working several teams together *in the same field* is common practice. A man owing several plows will ordinarily work all them together in the same field, even where one plow could easily finish the work in a work period of half a day. It seems common practice for villagers to exchange work so that two or more pairs of oxen can work in one field at a time. Aside from companionship, if one lead team is trained, the others follow and there is less trouble for the following drivers to control their animals. No other explanation has been given for the practice.

Efficiency of Working of Implements.—Table No. XIV shows the area covered per operator per day of 8 hours work in each district and with each tool or implement. With the exception of the patela, it will be noticed that all the implements and tools are small and the operator can cover a very small area per day with most of them.

TABLE No. XIV

Number of units of land (acres) covered in one day for each operation by all the implements (of 8 hours)

Region studied	Implements used in all the four regions							
	Wooden plough	Improved plough	Patela	Khurpi	Hansia	Phavra	Kassi	Kasla
Moradabad Region	1·0	0·47	5·0	0·16	0·12	..	0·08	0·16
Partabgarh Region	0·63	..	4·0	0·13	0·13	0·14	..	0·16
Allahabad Region..	0·75	0·75	6·1	0·12	0·10	0·12	..	..
Gorakhpur Region..	0·82	0·75	6·0	0·14	0·15	..	..	..
Average ..	0·8	0·59	5·3	0·14	0·13	0·13	0·08	0·16

From the results of the study, no explanation can be given for the variation in area covered per day in the different districts. In any case the figures are averages estimated by the farmers and depend on their memories and on their attention. It is certain that the man days required for many of the operations is very large and it is probable that the averages given at the end of the table are not far from the average for the areas covered.

This means that a family can manage only a small cropped area in a year. There is reason to believe that the average size of holding is fairly closely approximated in each area to that which can be handled with the implements and tools and the traditional methods and crops in a particular area. When it takes from 7 to 9 or 10 days to weed an acre of crop with a khurpi and when the process should be repeated two to three times in the comparatively short season, the area a person can control or that which a family can control even by the help of the women and children, is small.

One apparent anomoly in the table needs to be explained —the fact that in all districts reporting, the improved plow covers less area than the wooden plow. This is explained by the fact that the wooden plow does not do an effective job in one operation. While the surface appears to be all broken up, in fact the furrows made are v-shaped and shallow so that it is necessary to go over the field three to four times to get the same effective stirring of the soil with the wooden plow which could be gotten by once over with the improved plow. In preparing for the rainy season (kharif) crop, one plowing with the improved plow may be sufficient for preparing a usable seed bed while three to five may be required with the wooden plow. For the winter crops (rabi) it is not uncommon to plow 8, 10 or even 12 or more times with the wooden plow to finally prepare a seed bed for wheat. Similarly, the number of plowings required for the rabi or winter crop is very much reduced by using the improved plow. Where there is irrigation and double cropping is practiced, one through plowing with the improved plow plus 2 or 3 harrowings with spring tooth harrows or light cultivations with a horse hoe is quite sufficient. Where single cropping is practised, especially without irrigation, generally two plowings at least will be required, one about the middle of the rains and one just at the end, with two or three subsequent light cultivations is sufficient to give a good seed bed.

The improved plow of the soil turning type is not a complete substitute for the wooden plow, no more than the wooden plow is a complete substitute for the soil turning plow. Soil inversion is excellent when there is ample moisture or when there is organic matter to be buried. The kind of work the wooden plow does is desirable when there is deficiency of moisture and only light surface mulching is required to kill weeds and to prevent further germination of seedling weeds. The desirable combination is a soil inverting type improved

plow with a light cultivator of the general type of the bullock hoe or horse hoe type. This combination is beginning to be adopted but has not gone far enough to show up in this survey. Such a combination of implements, especially if the cultivator is used for interculture also, increases the area one man can control from 2 to 3 times without requiring a larger size of work animals. Increasing the size of the animals and of the implements to correspond will further increase the efficiency with which the man can work, or in other words the area he can control.

The number of days in a year a tool or an implement is used will affect the life of the implement. Where deterioriation is due to age, as in some wooden implements, as well as to wear, or where obsolescence may be a factor, a high intensity of use results in a low cost per unit of work for depreciation. Obsolescence is not as yet a very important factor in the cost of implements or tools but may become more so as improved types become more common. Table No. XV gives estimates of the number of days in a year that each of the tools and implements studied are used. This does not seem to require any comment.

Table No. XV

Number of days implements used in the whole year

Region studied	Wooden plough	Improved plough	Patela	Khurpi	Hansia	Gandasa	Phavra	Kassi	Kasla	Wooden fork	Hathia	Ankhein	Chaffcutter
Moradabad Region.	120	50	30	40	90	all the year	40	60	40	all the year	..	..	120
Partabgarh Region.	120		35	50	100	,,	25	..	..	,,	..	..	..
Allahabad Region.	100	40	30	45	100	,,	30			,,	..	..	..
Gorakhpur Region.	115	60	30	60	145	,,	25	..	..	,,	100	50	130
Average	114	38.	31	49	105	,,	30	60	40	,,	100	50	125

It seemed desirable to get some idea of the period of the year when each tool or implement was commonly used. Table No. XVI shows the average dates the farmers reported between which each of the tools and implements studied were in common use. It is probable that these are not extreme and it is certain that at times some implements and tools are used

at other times in at least some districts. For instance, both the wooden plow and the improved plow are reported to be used from June 1st. However, in a year when there is late winter rain so the ground is soft enough to plow, any vacant fields may be plowed in February, March or April. The hansia or reaping hook is a general purpose cutting tool, in some cases the only instrument possessed which can be used as a knife and so is used for all sorts of purposes from slicing vegetables to cutting the navel cord of new born infants. However, the table does indicate that the implements are not used the year round and there may be scope for extending the use.

TABLE XVI

Extreme limits of dates between which each implement is used in the whole year in all the regions.

Implements	Extreme limits of dates	
	Kharif season	Rabi season
Wooden plough ..	June 1st to 1st week of August.	1st week of August to middle of November.
Improved plough	June 1st to middle of July	Middle of July to middle of September.
Patela ..	1st of July to 7th of July..	1st of September to middle of October.
Khurpi ..	Middle of July to 30th September.	1st of November to 1st week of December.
Hansia ..	Middle of September to 7th December.	1st of March to end of April.
Gandasa ..	All the year round ..	..
Phavra ..	15th June to 15th July ..	15th October to 20th November and 1st February to end of March.
Kassi ..	1st of May to end of October.	..
Kasla ..	1st week of March to end of May.	..
Wooden fork ..	All the year round ..	..
Hathia ..	..	1st October to 1st January and 1st March to 15th May.
Ankhein ..	15th September to 15th October.	1st of April to end of June.
Chaffcutter .	1st of July to end of December.	..

Costs of labor and animal power per day in 1937 and in 1947.—The use of hired labor is a very important feature of Indian farming. There are a great many landless laborers, estimated up to 40,000,000 for undivided India as a whole and these are used to do the actual cultivation. Many comparatively small holdings now support two or more families where the "farmer" is actually a farm manager, who does little or nothing of the actual field work with his own hands but rather supervises the work of a lower caste landless laborer who does the actual work. The "farmer" looks after the business end of the holding, sometimes has some other interest or business, often is a gentleman of leisure. This is not universally true but is common enough to be of considerable importance. Figures were not secured, unfortunately, in this survey, of the number of holdings actually cultivated by the owner and the number on which more or less full time laborers were employed.

In addition to the above, the very low standard of accomplishment possible with many of the hand tools used for interculture and weeding makes the employment of casual or seasonal labor important especially for weeding and interculture, for irrigation, and for harvesting, particularly for the rabi crop harvest.

TABLE XVII

Cash wages of hired labour per day in 1937 *and* 1947, *in rupees, annas and pies.*

Moradabad Region		Partabgarh Region		Allahabad Region		Gorakhpur Region	
1937	1947	1937	1947	1937	1947	1937	1947
Rs. a. p	Rs. a. p	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p	Rs. a p	Rs. a p.
0 3 0	1 0 0	0 6 0	0 12 0	0 5 0	1 4 0	0 5 0	1 12 0

Average of all the four regions : 1937—Re. 0-4-9 ; 1947—Re. 1-3-0.

It is not known why the increase in wages has been so uneven in the different areas. The daily rate has doubled in Partabgarh area, it is 4 times in Allahabad, slightly over 5 times in Moradabad and 6 times in Gorakhpur as compared with the pre-war rate. The pre-war rate in Moradabad was low in comparison to other areas. In both Moradabad and Gorakhpur areas, development of sugar factories has given alternative industrial employment, while around Allahabad, the

construction of several large aerodromes, a civilian central ordnance depot, and large expansion of the arsenal in Allahabad fort has given much industrial employment. Doubtless the rise in labor rates is partly due to the general increase in alternative employment and partly is a part of the general inflation which has occurred. These increases should be compared with cost of grains in table No. XII to see the effect on the standard of living.

Some substitution of animal power for man labor is possible. With the prevailing practice of sowing at least two and often three or four different crops in a field mixed and broadcast at random, only hand weeding and interculture with small tools is possible. By seeding in lines, as is done in some parts of India and in other countries, it becomes possible to use interculture and so increase the work taken from the bullocks and implements, reducing the necessity for hand labor. Table No. XVIII shows the relation between the cost per pair of bullocks purchased in 1937 and 1947, the relation of the rates for hiring of bullocks and implements, and the approximate size of average bullocks commonly used by the farmers of the different areas.

TABLE XVIII

Cost of animals and animals labour per day in 1937 *and* 1947 *with approximate body weight of animals.*

Region studied	Cost of animals (per pair) 1937 Rs. a. p.	Cost of animals (per pair) 1947 Rs. a. p.	Cost of animal labour per day 1937 Rs. a. p.	Cost of animal labour per day 1947 Rs. a. p.	Approximate weight per animal
Moradabad Region	80 0 0	400 0 0	1 0 0	2 8 0	650 lbs.
Partabgarh Region	45 0 0	200 0 0	0 12 0	2 4 0	600 lbs.
Allahabad Region	40 0 0	174 0 0	0 8 0	1 12 0	700 lbs.
Gorakhpur Region	75 0 0	350 0 0	0 14 0	2 6 0	725 lbs.
Average ..	..	..	0 12 6	2 3 6	..

The practice of hiring bullocks rather than of keeping them permanently is fairly common. Some small holders hire bullocks and plows at the required season and do not own any at all, or they may own one and hire another. Some who have

rather more land than can be worked satisfactorily by one pair but not enough to justify two, may hire at rush seasons. Some owners who have less land than required to fully occupy their bullocks give on hire.

Usually the unit of one pair of bullocks, with yoke, plow and driver are hired as a unit. Usually owners will not give animals to be worked by others nor will they generally use the employer's implements. This is a measure to limit the load put on them and to ensure the good treatment of the animals. It is also partly that the animals are poorly trained and usually only accustomed to being driven by one person and cannot be satisfactorily handled by anyone else. So far, it is not common practice for anyone to keep animals especially for hire so the availability of animals depends on the season and on others finishing their work early. This may offer some scope for unemployed landless persons with some capital to make a business of doing custom work of this sort.

Comparison between traditional and improved methods.—This study afforded little material for comparison between traditional and improved implements or methods, largely because of the few improved implements brought to attention of surveyors. However, one or two useful comparisons can be made.

Table No. XIX is an attempt to calculate the cost of plowing with wooden and improved plows per acre. As in all such calculations, certain assumptions have to be made and those made in this case will be obvious from the table.

TABLE XIX

Cost of ploughing with one pair of bullocks at Moradabad using wooden plough (1947)

	Rs. a. p.	Rs. a. p.
One pair of bullocks: (based on one acre ploughed per day and 30 days of ploughing on 30 acres.)		
Interest on investment in a pair of bullocks (costing Rupees 400/- at 12% and use one-half time for ploughing)	24 0 0	
Depriciation on a pair of bullocks at 6 % (one-half)	12 0 0	
Feed per year (one-half)	360 0 0	
Housing (one-half)	0 0 0	
Total		396 0 0

	Rs. a. p.	Rs a. p.
Wooden plough :		
Interest on investment in the plough at 12% (costing Rs. 9/-)	1 1 3	
Depriciation of the plough (annually) ..	1 8 0	
Repairs on plough at 11 %	1 0 0	
Total ..	..	3 9 3
Labour :		
One labourer, 30 days at Rs. 1-4-0 per day ..	37 8 0	37 8 0
GRAND TOTAL ..	..	437 1 3
Less value of bullocksmanure ..	30 0 0	30 0 0
NET COST ..	..	407 1 3
Cost per acre for 30 acres (for one operation only)	13 9 0	

(*B*) *Cost of ploughing with one pair of bullocks at Moradabad using improved plough* (1947)

	Rs. a. p.	Rs a. p.
One pair of bullocks :		
Total cost for one-half the year (as above) ..	..	396 0 0
Improved plough (Gujar) :		
Interest on investment at 12% (costing Rs. 16) ..	1 14 6	
Depriciation on plough (annually)	1 0 0	
Repairs on plough at 11%	1 12 0	
Total ..	..	4 10 6
Labour :		
Total cost, one labourer, 30 days Rs. 1-4 per day ..	..	37 8 0
GRAND TOTAL ..	..	438 2 6
Less value of bullocks manure ..	30 0 0	30 0 0
NET COST	..	408 2 6
Cost per acre for 22½ acres (at 0·75 acre per day and for one operation only)	18 2 3	

Probably the fallacy in the above figures is that the actual "cost" is considerably less than the figure given, mainly in the cost of feeding bullocks. The cost used is based on the *market price* of feed stuffs in the city markets, and the assumption is made that these feed stuffs on the farm have this value. Actually the farm value is less by the cost of marketing. For farms well away from big cities, this cost of taking bulky roughages to the market may be fully as much as the price received so that at most the farmer gets wages for himself and his animals but nothing for the value of the roughage. Of course near a big market for such feed stuffs the situation is or may be quite different. Also where the farmer does his own work, his actual income may not be enough to pay him the wages used in the calculation.

However, since the same assumptions and figures have been used in both calcutions, they do not invalidate the comparison. On the basis of these figures, it costs more *per operation* to use the improved plow than it does the wooden plow. However, when it is remembered that one operation with the improved plow is certainly equal to two and often to 3 operations with the wooden plow, the comparison has a different aspect. The per operaton cost of Rs. 13-9-0 for the wooden plow to Rs. 18-2-3 for the improved plow becomes Rs. 27-2-0 for the wooden to Rs. 18-2-3 for the improved and if we use the ratio of 1 : 3, it becomes Rs. 40-11-0 to Rs. 18-2-3, showing a very large advantage in favor of the improved implement.

In the face of this large difference in favor of the improved implement, it seems strange that the improved implements have not displaced the wooden plow. The answer seems to be largely because of two things : the improved plows have been of unsatisfactory design and unsuitable material in many instance and have been poorly demonstrated ; as mentioned earlier, the improved plow has not been found a complete substitute for the wooden plow but requires an auxiliary implement also to complete the substitution. The improved supplementary implement is costly in comparison and has not been pushed or demonstrated but rather it has been recommended that the wooden plow be continued. If the wooden plow is kept, the temptation is to use it all the time. It is believed that with improved designs and correct material (steel instead of cast iron) and with more correct demonstration, the wooden plow can be displaced in a decade or two.

Cost of cutting chaff from fodder at Moradabad, 1947.—Practically all roughage fed to cattle in India is first chaffed. The roughage consists very largely of stover of maize, sorghums and millets but includes straws of all the common cereals grown, some grass and a limited amount of fodder grown especially, mostly sorghums and millets. The straws of the cereals are broken up in the threshing process but the stovers and fodders and some grass gathered from waste land and weeds from the crop land is chaffed before feeding.

Traditionally, this is done by chopping with a heavy cleaver or chopper made of a steel blade set in a wooden handle. A wooden block is set on end in the ground so it projects only an inch or two above the ground. The person squats on the ground near the block, grasps a handful of the material to be

chaffed with one hand and wields the chopper with the other. The material is cut finely, usually only $\frac{3}{8}''$ to $\frac{1}{2}''$ in length. This is a slow process, laborious and dangerous to the hand grasping the fodder. In order to cut finely, the chopping is done close to the hand and mutilated hands are common in the villages.

Small hand driven chaff cutters were introduced from Europe mainly but some from U.S.A. Before the war, local manufacture in the Punjab particularly had become widely developed and they were coming into wide use. Unfortunately, war shortage of materials has hindered general introduction in the area covered by the study and only 2 were noted on the farms studied. Table No. XX gives details of costs for chaffing fodder by hand and by the improved chaff cutter.

TABLE XX

Cost of cutting fodder by gandasa (chopper) at Moradabad, (1947)

	Rs. a. p.	Rs. a. p.
Gandasa: (based on $2\frac{1}{2}$ maunds of fodder chopped per day by one man, and used for 365 days)		
Interest on investment, depriciation, and repairs (taking Rs. 2 as cost and $1\frac{1}{3}$ years as life of it)	0 3 9	
Labour:		
One labourer at Rs 1-4-6 per day for 365 days ..	456 4 0	
Totol cost of chopping 912 maunds of fodder ..	..	456 7 9
Cost of chopping fodder per day	1 4 0	
Cost of chopping one maund of fodder ..	0 8 0	

(b) Cost of cutting fodder by hand chaffcutter at Moradabad, (1947)

	Rs. a p.	Rs. a. p.
Hand chaffcutter: based on 20 maunds of fodder chhoped per day, and used for 120 days only—		
Interest on investment (costing Rs. 100 only) at 12%	12 0 0	
Depriciation (annually)	5 0 0	
Repairs and miscellaneous charges (as lubricant, etc.) at 10%	10 0 0	
Total ..	..	27 0 0
Labour:		
Wages of two boys at -/12/- per day for 120 days	180 0 0	
Wages of two men at Rs. 1-4-0 per day for 120 days	300 0 0	480 0 0
GRAND TOTAL ..	..	507 0 0
Cost per day for chopping 2400 maunds of fodder in 120 days	4 3 0	
Cost of chopping one maund of fodder ..	0 3 4	

Actually the chaff cutters are not used full time or all day, in most cases but for short periods morning and evening to chaff the necessary fodder. However, the comparison of the two methods is valid. When used for short periods only, the number of people required to work it is also reduced, without correspondingly reducing the output. One boy to put in fodder and a man to turn the handle are sufficient to work it but because the work is heavy, reley working is necessary. When only small amounts are chaffed at a time, one man and one boy can work it till tired and if not enough is cut, change off to other work and again come back to the chaff cutter after some rest. This reduces the cost of labor per maund (82 lbs.) and makes the comparison more favourable to the chaff cutter. Only shortage of supplies is hindering the rapid introduction of such chaff cutters. The introduction will be even more rapid if somewhat better quality machines are available. Heavy demand has tended to encourage poor quality in order to get cheapness and some of the machines sold have been very poor.

Cost of Harvesting and Threshing.—Partly from the survey and partly from figures from the Agricultural Institute records, some comparison of costs of harvesting and threshing is possible. Table No. XXI shows the cost of harvesting, that is cutting and binding but not hauling to threshing floor.

TABLE XXI

Cost of harvesting one acre of crop area with hansia (sickle) at Moradabad, (1947)

	Rs. a. p.	Rs. a. p.
Hansia: (based on 0 12 acre of crop harvested in one day)—		
Interest, Depriciation and repairs (cost Re. 1 and life 2 years)	0 1 6	
Labour:		
One woman labourer, 8½ days at Re. 1 per day..	8 8 0	
Cost of harvesting an acre of crop	8 9 6	

At the Agricultural Institute, hand harvesting with the reaping hook or hansia and hauling to the threshing floor on bullock carts cost Rs. 10-11-10 per acre. This includes depreciation on carts, actual wages to labor who provided their own hansias, and supervision charges.

The crop was threshed with a rather old stationary thresher driven by an electric motor with current costing

Re. 0-1-9 or about $3\frac{1}{2}$ ¢. a unit. Part of the crop was threshed direct from the carts bringing it from the fields, part was unloaded and had to be lifted and carried to the thresher. The thresher was operated by the Institute workshop and depreciation on the machine, overhead on supplies and repairs and supervision on the labor was charged. The average cost of threshing was Re. 0-11-10 per maund.

On average yields at the Institute, this worked out to Rs. 16-10-8 per acre for harvesting and threshing, using the traditional reaping hook with hired labor for harvesting and the old stationary thresher.

In 1947 and 1948 harvests a combined harvestor-thresher was used. In 1917, the machine was a pulled type No. 62 IHC Machine, being used for the first time on loan from the Department of Agriculture. In 1948, a Self Propelled Massey Harris Clipper was used. Both operated on petrol, the No. 62 being drawn by a kerosene burning tractor. The costs per acre as follows :—

1947 with pull type harvester. Rs. 11-8-9 (did not include hauling of show from field).

1948 with self propelled, including hauling of straw Rs. 17-10-0.

In both cases the conbines were new, the staff was inexperienced and it was necessary to spend time adjusting and in some cases adopting the machine. Most of the time double crews were used to teach additional operators but charged to cost of harvest.

The traditional method of threshing is to put the crop down on the previously prepared threshing floor and to trample it under the feet of exen. An average charge is approximately 20 maunds of grain though this will depend on the ratio of grain to straw. Under favourable conditions—the straw dry and brittle, no rain, no heavy dew, about 3 days will suffice to thresh the grain out and to break the straw into fine condition.

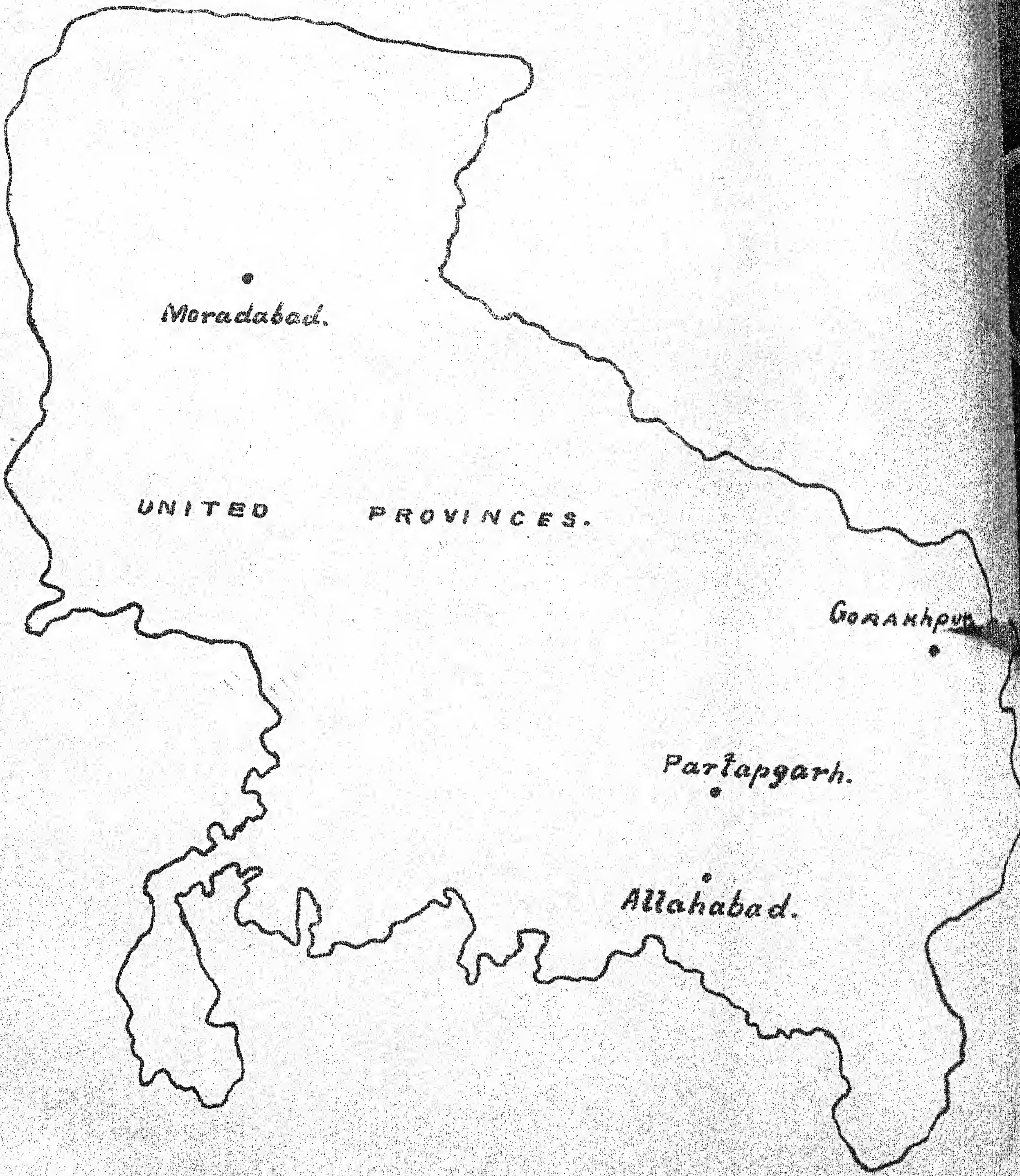
In conclusion, it may be said that the study has not uncovered any very tremendous fact not already known. It has put together and gotten on paper the extremely limited resources with which the Indian farmer has to work in the matter of equipment. It does show that the holding on which the tools are used is small and that the implements require an enormous expenditure of time and labour per unit area to accomplish the work to be done.

It should also call attention to the fact that the implement problems of the Indian farmer are no less pressing than those of farmers in western countries, even though they are quite different in nature. Essentially the problem of the Western farmer is to cover the maximum area in the time available. The problem of the Indian farmer is to get the maximum yield out of a small holding which he has little or no opportunity to enlarge and which cannot provide the capital for a very large investment in tools or implements. Perhaps the invesment possible has been understimated in the past but it certainly cannot be large in the sense that the investment on farms in America and Western Europe is large.

Until recently, the implement problems of the Indian farmer have tended to get less attention than the plant breeding, entomological and pathological problems. Now there is a trend toward trying to solve these problems by the wholesale importation of implements and implement practices from areas where the population situation is quite different, where the holdings are far larger and capable of expension as they are not in India.

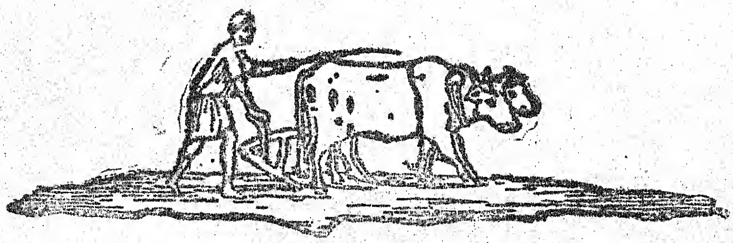
If this study results in calling attention to these problems, if it results in getting a closer study of them and of related Agricultural knowledge, it will have served its purpose. If it is taken as the last word and as a sufficient source of knowledge on the subject, it will have failed. Even for the area it covered, it makes little or no contribution to item 3 of the four purposes set for the survey on page 463. Far more information is needed on item 2, the efficiency in use of implements.

It is the hope of the author that item 4 of the purposes will to some extent have been accomplished, that it will stir others to a more intensive study of the tool and implement problems of the Indian farmer. It is hoped that the greatly increased interest in agricultural engineering in India will reach to those interested in farm management and in rural economics and that they will also make studies along these lines. While the agricultural engineer has important contributions to make to it, the field is also one in which farm management and rural economics specialists can and should make significant contributions.



MAP OF U.P. SHOWING THE PLACES WHERE THE SURVEY WAS CARRIED OUT.

THE ALLAHABAD FARMER



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EDITORIAL

CROSSBREEDING DAIRY CATTLE

By JAMES N. WARNER M. Sc.

The world's record milk production during a period of 365 days is now held by Carnation Madcap Ormsby Fayne, a Holstein-Freisian cow in the United States. Her record was 41,943 lbs., an average of 114·9 lbs. each day for a full year. The second highest record is 41,644 lbs. held by Cherry, an English Shorthorn cow. According to recent publications, the most milk produced in one lactation by a single cow in this country is 19,682 lbs., produced by a crossbred cow. By contrast, the greatest production recently during one lactation by a zebu cow was 14,692 lbs. produced by a Sahiwal cow.

Perhaps the highest average annual production of milk by farm cows in any one country of the world was 7260 lbs. in 1938 in Denmark. Farm cow annual averages in the United States, Canada, Australia, England, New Zealand, Germany, and other important dairy countries, have varied between 4000 and 6000 lbs. during the past decade or so. Several averages of 5000 to 5500 lbs. have been reported recently. By contrast, the average annual production of zebu cows in this country is less than 1000 lbs.; for buffalo cows, about 1600 lbs.

Climatic conditions and disease incidence may be less favourable for milking cows in India than in many of the

best dairy areas of the world, and there are innumerable production records elsewhere which excell anything ever experienced in this country. By contrast, individual exotic cows, when brought to India, have excelled indigenous zebu cows, and exotic-indigenous crossbred cows frequently produce more milk than pure indigneous cows.

Western dairy breeds have been developed to a considerable degree of efficiency as milk producers. Those breeds produce great quantities of milk in their native countries, they have proved themselves capable of doing better in this respect in this country, under certain conditions, than our own native stock. These facts suggest that we might benefit by importing good western dairy stock, that we should be able to increase our milk production considerably by this means. Our need for additional milk—three times, in fact, what we now have—is extremely urgent.

Three methods of using foreign dairy breeds for this purpose are possible. Firstly, the exotic or taurus stock could be imported and bred pure under farm or rural conditions, the former definitely being preferred, at least in the beginning. Secondly, taurus stock might be imported and mixed with our zebu stock by crossbreeding. Thirdly, semen from the best herds in the west might be imported by air and used for artificially inseminating zebu cows to produce crossbred progeny.

The second and third alternative will probably prove more effective than the first since they would give animals which would be simultaneously high producing and, to a certain extent, acclimatized. Furthermore, the importation of bulls or semen for crossbreeding purposes would involve noticeably less expenditure for the foreign stock than the importation of sufficient females to breed pure exotic stock in numbers large enough to benefit our country appreciably in a short time. While the importation of semen involves many problems, some of which may not be fully understood as yet, this method might involve even less expenditure, although this is not certain, than the importation of bulls.

For many years this Institute has been maintaining herds of Red Sindhi zebus and Murrah buffaloes. Selective breeding practices have been followed in the management of both. We shall continue to maintain these breeds and to develop them to as high a degree of efficiency for milk and butter fat production as is possible.

In addition, we have imported exotic bulls from time to time for crossbreeding purposes. We have now, in addition to the two groups mentioned above, a herd of crossbred cows, consisting primarily of Jersey and Red Sindhi crosses. This work is based on the belief that western breeds have inherent milk and butter fat production potentials which are greater than our indigenous breeds have, and that it is possible to put these inherent capacities into our animals by crossbreeding. The results of this work thus far have convinced us that not only can milk production be increased but better exotic animals than we have used so far would give even better results. Because of this conviction we are continuing to crossbreed, to select for milk and butter fat producing capacity within those crosses, and to import the best Jersey animals we can obtain for this purpose.

Accordingly, a few years ago we undertook negotiations with the United States Department of Agriculture, Bureau of Dairy Industry, for exchanging selected purebred Red Sindhi stock from our herd for selected purebred Jersey stock from their herd. Two Red Sindhi heifers and two Red Sindhi young bulls were shipped from this institute to the United States in 1946. This exchange has now been completed by the arrival of two Jersey heifers, one Jersey young bull and one Jersey-Sindhi young bull from the United States on January 15th, 1949.

The United States Government is undertaking to develop an efficient dairy animal for their semi-tropical Gulf states. They believe the Red Sindhi zebu possesses characterestics which would be useful for this purpose. The Bureau of Dairy Industry officials were interested in this exchange, therefore, as a source of excellent Red Sindhi breeding stock for their purpose, and as an opportunity to contribute what they can to the improvement of the productivity of dairy stock of this country.

One Jersey bull, Passport's Jap, which was imported by this Institute in 1923, produced descendants in our herd whose average lactation production was always 800 to 1000 lbs., sometimes nearly 3000 lbs., greater than the average production of the original Red Sindhi cows from which they sprung. No less than 4,00,000 lbs. of milk have been produced thus far in our herd as a direct result of crossing Red Sindhi cows with this one bull. There are at present over 60 of Passport Jap's descendants remaining in the Institute herd whose productive life is not yet complete.

Furthermore, each of these will in turn have descendants, as yet unborn and unnumbered, whose production will be greater because of this Jersey ancestry.

The producing potential of Passport's Jap, judging from the production of his daughters and their mothers, and using the intermediate index method of measurement, was only about 7200 lbs. of milk. While the new Jersey animals are not old enough to have been proved as yet, there is reason to believe that they will be considerably better. Judging from their pedigrees, it seems reasonable to expect that they present a milk production potential, in genetic terms, of about 10,000 lbs. of milk per lactation. It is too early to estimate what their contribution might ultimately be. It seems conservative, however, to presume that they might each some day prove to have been responsible for the production of many lakhs of pounds of milk more than we would otherwise have produced.

CATTLE IN INDIA—PROBLEM OF NUMBERS

BY H. J. MAKHIJANI*.

The low efficiency of the country's cattle has become proverbial and despite its large cattle population of 186 millions (taurine), there exists deficiency both in the cattle working power and in milk production : the former is evident from the poor type of cultivation and low yields of crops and the latter is obvious from the estimated average annual milk yield of 525 lbs. per cow. While these deficiencies are compelling the cultivator to maintain more cattle for meeting his requirements of bullock power, the experts are of opinion that the low efficiency is in itself due to the very large cattle population and that the remedy does not lie in further increase in their numbers but rather in their rational decrease. It is, therefore, of interest to examine the whole position and know the country's requirements of cattle population.

The first requirement of Indian cattle is to provide power for agricultural operation—milk production being a secondary requirement. Therefore the Indian cattle have been selected and bred for ages for draught purposes and there exist five draught breeds like the Kankrej of Gujrat (Bombay Presidency), the Tharparkar of desert region of Sind, the Bhagnari of North Sind, eastern Baluchistan and Bahawalpur State, the Hissar and Hariana of South eastern Punjab, the Malvi of Central India, the Amrit Mahal and Halikar of Mysore State and the Ongole and Kangayam of Madras Presidency. The recent move towards mechanising agriculture and road transport, etc., would to an extent relieve the cattle of some heavy work, but it is not likely to replace them to any appreciable degree for the following reasons: low economic position of the cultivator, smallness of holdings, high cost of machinery and its upkeep, non-availability of trained labour and their high wages, little scope of alternate employment for the agricultural labour that may be displaced and lastly decreased occupation resulting in lower income of the cultivator himself.

Land and Cattle Resources.—

The expanse of the country is estimated at 1000 million acres and the Advisory Board of the Indian Council of Agricultural Research in their Memorandum on Development of Agriculture and Animal Husbandry in India (1944) have estimatad the utilization of land as given in Table I.

*Reproduced from *Rural India*, March 1947.

TABLE I.

Utilization of land in India.

Distribution of land.	Million Acres.			
	British India	Reporting States	Estimates for nonreporting States	Estimated total
1. Under forest ..	68	15	20	107
2. Not available for cultivation.	93	28	160	281
3. Culturable waste ..	92	19	60	171
4. Current fallow ..	45	14	20	79
5. Under cultivation ..	214	68	80	362
Total ..	512	148	340	1000

The country's cattle (taurine) population is estimated at about 186 millions and its distribution is given in Table II. Figures for British India and reporting States are taken from the Agricultural Statistics (1937-38) and those for non-reporting States are estimates, giving 20 bullocks, 0·3 bulls, 17·6 cows and 15·0 youngstock—a total of 52·9 heads per 100 acres culivated area.

TABLE II.

Population of Cattle (taurine) in India.

Class of Cattle	British India	Reporting States	Estimates for nonreporting States	Estimated total
Bullocks Bulls ..	48·6	14·3	9·5	71·4
Cows	37·0	14·0	9·3	1·0
Young Stock	33·0	12·3	8·2	53·5
Total ..	118·6	40·6	27·0	186·2

Possible Future Requirements.—

Work Cattle: There are now 20 bullocks working for 100 acres cultivated area, *i. e.*, one pair for 10 acres. Dr. W. Burns (Technological Possibilities of Agricultural Development of India, 1944) contemplates the possibility of development in the cattle-working efficiency of 60 per cent by better feeding, breeding, management and disease control. While this appears to be possible, one should not forget the present insufficiency of bullock power and the resultant poor type of cultivation. Providing 20 per cent of extra power to cope with the present shortage, contemplated improvement in cultivation and double cropping of greater area, likely saving of 10 per cent on account of possible mechanization of agriculture and road transport, one pair of bullocks will be required for about $10\times\frac{160}{100}\times\frac{100}{120}\times\frac{110}{100}=14{\cdot}66$ acres. This appears to be quite a fair estimate as compared with the efficiency of well-bred cattle of Hariana, Malvi and Ongole tracts where a bullock is maintained for 6 to 7 acres cultivated area (ICAR Misc. Bull. 22, 1938). There are 362 million acres of land under cultivation and 79 million acres lying as fallow are contemplated to be developed and brought under cultivation. Thus for 441 million acres likely to be under cultivation, 60·4 million bullocks, will be required against the present strength of 71·4 millions.

Breeding bulls: Considering the smallness of herds, extensive distribution of cattle and seasonal breeding of cows, one bull for 400 acres area may be considered a reasonable requirement. At this rate for the country's total area of 100 million acres, 2·5 million breeding bulls are necessary.

Male calves: For continuous maintenance of required number of bullocks and bulls, male calves shall have to be reared to replace the ones that die, and those that get old and inefficient. The number of calves required to be reared will depend upon the average useful life of the adult animal, the age at which the young animal can be put to work or for breeding and the rate of mortality among calves in rearing. The average working life of the bullock is rather a controversial point. The Royal Commission on Agriculture in India (1928 p. 195) have mentioned Stewart and Singh's work on determining the cost of feeding plough cattle in certain Punjab districts and said, 'To the actual cost of feeding they have added 20 per cent of the value of the cattle for interest and depreciation. This rate is substantially

larger than the rate we have assumed in our estimate, based on the localities investigated'. And at another place (Ibid. p. 213) discussing the requirements of breeding bull they have said, 'and would, if its cattle were properly managed, need one million with an annual supply of some 20,000 thus contending an average useful life of a bull to be 5 years'. Mr. Rajendra Prasad in his report on cattle and milk production and consumption in deltaic ares of Bihar, (ICAR Misc. Bull. 22, 1938) while describing the health of cattle has said, 'The bad health is manifested by the fact that cows become unfit for breeding only after 3 to 6 lactations'. Taking these statements into consideration and also the common knowledge regarding high incidence of cattle diseases and mortality, it seems a safe estimate to take 7 years as the average working life of a bullock. Putting it the other way, the young bullock comes to working age at 3½ years and has an average working life of 7 years *i. e.*, its average span of life is 10½ years. With better feeding, management and disease control it may be possible to raise the average period of its useful life by 25 per cent to 30 per cent, *i. e.*, from 7 to 9 years (3 years to 12 years age) and at this rate 7 million adult males would require to be replaced annually and for this 8·75 million male calves would require to be reared annually allowing for mortality at 20 per cent among calves for rearing up to 3 years age.

Breeding Cows :

The production of 8·75 million male calves annually maintenance of an adequate number of breeding cows will become essential. The Royal Commission on Agriculture (1928, p. 183) have mentioned, 'We were informed that cows in this country might be expected to calve at intervals of about 18 months. The census figures suggest that the average intervals may be nearer three years than two.' A village enquiry conducted by Indian Council of Agricultural Research (ICAR Misc. Bull, 22, 1938) has revealed the average calving interval for cows in seven cattle breeding tracts, to be 18·2 months. The average calving interval of cow on an all India basis may be 24 months and it is possible with better feeding and managment, it may be brought down to 18 months. Therefore taking 18 months as the calving interval and ratio of male to female calves as 50 : 50, $8{\cdot}75 \times 18/12 \times 2 = 26{\cdot}75$ million cows would be required.

Cow Calves : Taking an average breeding life of a cow as 9 years (3 years to 12 years) it will be necessary to have

2·9 million cows annually to replace those that die or become senile. On the same basis as for the male calves, 3·66 million cow calves shall be required to be reared annually and this will give a total strength of 10 million cow calves in rearing. Therefore the country's cattle requirements for supplying the required bullock power under conditions of proper management and feeding and breeding works out as :

1.	Working bullocks	60·4	Millions
2.	Breeding bulls	2·5	"
3.	Breeding cows	26·3	"
4.	Male calves in rearing up to 3 years age ..	23·6	"
5.	Cow calves in rearing up to 3 years age ..	10·0	"
	Total ..	122·8	Millions.

Utilization of Surplus Cow Calves :

It has been shown above that 26·3 million cows will give annually about 8·75 million cow calves of which only 3·66 million will be required for rearing purposes to maintain the regular strength of cows at 26·3 millions. Thus, there will be an annual surplus of about 5·1 million cow calves for which profitable use shall have to be found out. This problem will not arise if sex-inheritance in animals could be controlled and till such time as this becomes possible, this surplus will continue to exist. Unless the surplus is fully made use of, the cattle industry will not be profitable enough and will have a far-reaching effect on agricultural business. Such a position is existing since long and the cultivator-owner instead of exploiting this wealth, has neglected it resulting in a gradual deterioration of all cattle. Cow and cow calves unless of good milch type, are neglected and left to find their feed where they can, resulting in overcrowding on the village pastures and the consequent underfeeding and deterioration of all cattle depending for their subsistence on the grazings. Nature then starts setting up an equilibrium. The size of the animal gets adjusted to suit the conditions of feed and management and the weaklings die off either of starvation or disease. The productive and reproductive activity of the cow declines and the growth in youngstock slows down resulting in their maturity at a late age. The Royal Commission on Agriculture in India (Ibid., p. 224) found in 1926. "There are many districts in which cows can with difficulty rear their calves" and since then 20 years have elapsed and this deterioration has marched into many more districts. Surely such cows cannot be expected to give a

progeny of robust bullocks and high milk-yielding cows. Efficiency of cattle has thus progressively declined necessitating the maintenance of a greater number of cattle for work and milk production (Ibid., p. 224) found in 1926 'Therefore for any contemplated improvement it is essential to maintain the necessary number of cow calves in a good condition, and to find out a profitable use for the surplus ones.'

Milk requirements and Production :

The importance of milk in human diet has been universally recognised and it is now accepted that no diet is complete unless it contains a minimum of 10 oz. of milk. Famine Enquiry Commission (1945, p. 106) quoting the Nutrition Advisory Committee have suggested a minimum per capita daily consumption of 10 oz. milk for maintenance of good health. The Report on Marketing of Milk in India and Burma (1941) gives an estimate of per capita production of milk in India at 5·8 oz., of which only ?7 per cent is used for consumption as whole milk.

Mr. M. Afzal Husain a member of the Famine Enquiry Commission (1945, p 340) has quoted from the findings of the Nutrition Advisory Committee, 'even when the Indian diet is quantitatively adequate it is almost invariably ill-balanced. In terms of food factors the most important deficiencies are those of proteins of high biological value, fat, Vitamin A and carotene, vitamin of B group and calcium.' Fortunately milk is both a nourishing beverage and also rich in these protective subtances and a daily intake of adequate quantities of it insures a sufficient supply of substances of high food value. Supplementing the diet of school children with added quantity of milk has resulted in their better growth and prevention of nutrition deficiency diseases. Mr. M. Afzal Husain (Ibid. p. 341) has further quoted from the Economist, dated 26th December, 1936, 'Clearly the most important task confronting the social reformer who seeks to make India's food supply satisfy decent standards of nutrition is to increase milk production in India. A doubling of India's milk supply will not only increase the quantity of first class protein available per head but will also increase the element of animal fat in the Indian diet which at present is largely supplied by vegetable oil.' Increase in production of milk seems to be the immediate necessity and the Government of India have aimed at a 300 per cent increase. Milk production, though a secondary function of the Indian cattle, is yet of immense national importance and offers scope for utilizing the surplus cow calves.

Developing Milking Quality in Draught Breeds:

This subject has received consideration of experts from time to time. One school of thought is in favour of developing cattle breeds for different purposes, *viz.*, draught or milk, on consideration that development of cattle would be quicker when breeding for one specific purpose than for combination of characteristics and suggest that the cultivators should be given one breed for his requirements of bullock and another for milk production. The other school of thought is of opinion that for the cultivator to maintain two different breeds without much inter-breeding is rather difficult and suggests that the safer course lies in developing reasonable milk in the draught breeds in view of the example of Britain, as one of the prominent witnesses in his evidence before the Royal Commission on Agriculture (Ibid. p. 210) put it '......... and not until enclosures made it possible for the farmers in Britain to control the promiscuous mating of animals, that the breeding of livestock for which that country is now famous became possible.' The Royal Commission on Agriculture in India in their report (p. 124, 1928) while discussing the problem has said, 'in many parts of India the quantity of milk now produced by the cattle of cultivators is not sufficient to provide their owners with the supply desirable for their own use. In such circumstances measures to improve the milking qualities of cattle are very desireable. The type of cow likely to suit the average cultivator would be one capable of rearing a strong calf and of supplying in addition some 1,000 to 1,500 lb. milk per lactation for household use.' Milking is an inherent quality of the cow, and quantity of milk she gives depends to a great extent on the feed, care and stimulation she recives. Cows of draught breeds have never received a generous feeding and care of their owners and their present milk yield can by no meens be taken as the index of their capacity. Dr. Wright while discussing in his Report on the Development of Cattle and Dairy Industries of India (p. 69, 1937) the desirability of developing cows of higher milking strain was of opinion. 'I should perhaps add that I do not consider that such efforts should be limited to those breeds which are recognised as predominantly milking types .... that improvement can be looked for in the milking capacity of most breeds other than those of purely draught types, such as Amritmahal and the Hissar breeds. Even the latter breed is found to possess strains of special milking potentialities.' Originally all the Indian cattle were bred for draught qualities and dairying

as a business was not even conceived. There were vast stretches of rich pastures for cattle to graze and feed on. Every family owned land and cattle always had ample milk for the family's needs. With the progressive growth in population, pastures of former days have been and are being tilled to meet the food requirements of man, and the requirements of cattle have not received enough consideration thus leading to their gradual deterioration. But in tracts where there still exist vast stretches of uncultivated land and where the cultivators have been careful enough to make adequate provision for their cattle, there do exist some of the finest breeds the country is proud of. Some of these are the Red Sindhi and Tharparkar breeds of Sind; the Sahiwal and Hariana breeds of the Punjab; the Gir breed of Kathiawar; the Kankraj breed of Gujrat, Bombay Presidency; and Ongole breed of the Madras Presidency. These breeds have subsisted on rich pastures and their milking potentialities have been greatly appreciated. The existence for generations of very general purpose breeds in the Tharparkar, the Kankraj, the Hariana, the Ongole and the Gir lead one to believe that most of the Indian cattle could by adequate feed and care be brought to that high standard both in draught and milk qualities—all that is necessary is to develop the inherent qualities which have gone latent on account of the animal's constant struggle between life and death. In developing the milking qualities in breeds suitable standards for lactation yields for different breeds should be set as a guide in fixing the type, simultaneously keeping in view the greater importance of draught quality. Prof. James Warner is of opinion that the results obtained in such places as Karnal and Patna with Tharparkar breed and at Muttra with the Hariana, indicate that yields up to 5,000 to 6,000 lb. of milk or more a year do not necessarily reduce the draught ability of our animals, (Indian Farming, Vol. VII, pp. 195—197). Safe milking standards for some of the breeds may be as under :—

Breeds	Average lactation milk yields
(1) Red Sindhi and Sahiwal	4,500 lb.
(2) Tharparkar, Hariana Kankrej, Gir, Ongole	3,500 „
(3) Bhagnari, Hissar, Malvi	2,500 „
(4) Amritmahal, Hallikar, Khilari	1,500 „

Cow for Milk Production :

The average annual milk yield of a cow, after feeding the calf, is estimated to be 525 lb. and Dr. W. Burns (Technological Possibilities of Agricultural Development in India, 1944) contends possibilities of 75 per cent increase in average milk production due to :

Proper feeding	30 per cent
Breeding	15 ,,
Management	15 ,,
Disease control	15 ,,
	75 per cent

This appears to be rather a conservative estimate in view of the fact that the cow stock is rather totally neglected and the present estimate for yield is not indication of its milking capacity. To describe the 'treatment to cow' in the words of Royal Commission on Agriculture in India (Report p. 173, 1928) who bring out a true picture of the things, 'Broadly it would be true to say that, if there is any fodder available after the draught cattle are fed, she gets it, or shares it with the young stock, for the rest she is left to find the food where she can. Where the cow provides some milk for the household as well as for the calf, cultivators try to spare her two to three pounds of a mixture of cotton seed and bran, or oilcake, or pulse, but when her milk fails, the ration is withdrawn and she is turned adrift to find a living for herself on grazing'. Col. A. Olver (Agr. and L. S. in India Vol. VI) while discussing the possiblities of mixed farming in India has testified that 'As an example of what scientific feeding and management can do, even in a very unfavourable locality, the greatly improved results obtained, during the year 1932-33, in the cross-bred dairy herd of the Indian Veterinary Research Institute Mukteswar, are of interest .... the average daily milk yield per cow was increased from 8·15 lb. to 14·6 lb. . ... this result is a very striking evidence that the poor results generally obtained in such areas are to a very large extent due to lack of proper feeding and management.' Under such conditions, it is reasonable to expect at least 100 per cent increase in milk yield of cows with better feeding (50 per cent), management (20 per cent), breading (15 per cent), and disease control (15 per cent). Thus the everage expected annual yield per cow would be about 1050 lb. The annual requirement of milk at the mini-

mum per capita daily, consumption of 10 oz. for 'good health' works out to 91,250 million pounds and assuming that 50 per cent of the milk requirements would be supplied by the cow stock and 50 per cent by the buffalo stock as at present, maintenance of 43·5 million cows will be necessary and accordingly the requirement of cattle population works out to:

Bullocks	60·4	million
Bulls	2·5	„
Cows	43·5	„
Male calves in rearing	23·6	„
Female „ „ „	17·2	„
Total ..	147·2	„

This will still leave us an annual surplus of 14·25 million calves—male calves 5·75 million and female calves 8·50 million.

Cows for Work:

Possibilities of putting to work female stock of draught breeds, whose potentialities for milk production are so low as not to pay for their feed consumption, require to be explored. Prof. James Warner (Indian Farming, Vol. VII, No. 4) pleads, 'why not use our cows for draft purposes? They do so in Europe and still get more milk than we do ... we might investigate the possibility of working our cows, particularly those which produce a calf only every 20 months or so ....' The Famine Enquiry Commission (1945, p. 184) while discussing the same question has quoted Lamartine, Yates and Warriner, '.. For instance, in Switzerland, where in some districts the holdings are small, the peasants are urged, not always successfully, by their economic adviser to use a cow for ploughing and other field operations. The effort of working, it is true, somewhat lessens the cow's milk yield, but the loss is small compared with the cost of keeping a horse.' There appears to be a reasonable scope of harnessing breeding stock to light work and non-breeding stock to medium work.

Need for New Outlook:

It has been shown above that with the strength of cows at 43·5 millions, there is likely to be annual surplus of 5·75 million bull calves and 8·50 million cow calves. The annual increase in human population is estimated at 5 millions and while this growth takes place, it will be neces-

sary to produce more food and milk to satisfy their hunger. This may be partly met by increase in yield of crops and milk by adopting better practices and partly by developing and cultivating land lying as 'cultivatable waste' which is estimated to be 171 million acres. Within next 20 years there appears possibility of commissioning 50 per cent, i. e., 85 million acres of this land for growing food crops. For this extra land, an additional strength of 6 million working bullocks may be required. On the side of milk production the cultivation is based on the basis of daily per capita consumption of 10 oz. milk against the optimum desired requirement of 20 oz. While some increase in milk production may result from progressive improvement of milch cattle, it appears rather doubtful if we would achieve that level of milk production to make possible 20 oz. per capita daily consumption, without suffering serious shortages of other food crops. The Famine Enquiry Commission (1945, p. 125) is of opinion '...... we cannot visualize any immediate possibility of increasing the production of milk to such an extent that it can become a regular article of diet consumed in adequate quantities by the poorer classes in the greater part of India .... ' Every effort must, however, be made to increase supplies of milk products, and we regard this as a most important aspect of food policy. The more milk the better, even if all cannot be adequately supplied. The production of milk, therefore, should be increased to supply at least per capita daily requirement of 10 oz. which is the minimum necessary quantity recommended by the Nutrition Advisory Committee for maintenance of 'good health.' The problem that will again face us is to dispose of profitably the surplus stock that would result from better feeding and management of cattle as contemplated—and if this is not done, there is bound to be overstocking and consequent malnutrition and repetition of the cycle. Some may suggest the possibility of utilizing the surplus cattle for beef. It is true, this is one of the ways to dispose of the surplus numbers, but it may be realized that beef production is highly uneconomic, requiring per unit food production 10 times the area than required for food crops. Moreover it is an established fact that dairy and draught type animals, as indeed our cattle are, are not at all suited for beef production. Naturally, beef production can never find a place in the economy of the Indian cultivator.

Another possibility of disposing of the surplus stock may be in developing export trade in cattle with countries where

demand for the Indian cattle exist on account of its high efficiency as work animal, great power of endurance, high resistence to cattle plagues and tick fever and ability to thrive under unfavourable conditions of climate, feed and management. Some of the countries where demand for Indian cattle exists are Ceylon, Burma, Malaya, Philippine Islands, Middle East countries and Tropical America. The export trade in cattle, though profitable, is unlikely to absorb all the surplus stock of about 14 millions annually. So the best policy seems to be to have as few cattle heads as necessary, consistent with the optimum requirements of draught power, minimum essential requirements of milk and the lowest possible surplus of calves which may be needed as the area under cultivation increases from year to year and for the export trade. Accordingly the possible requirement of the cattle population that would meet all these demands appears to be :

(1) Bullocks	.. .. ..	47·5 millions
(2) Bulls	.. .. ..	2·5 ,,
(3) Working cows	.. .. ..	10·0 ,,
(4) Working and breeding cows (average annual milk yield per cow 1000 lb.)	.. ..	20·0 ,,
(5) Breeding cows (average annual milk yield per cow 2000 lb.)	.. .. ..	20·0 ,,
(6) Male young stock under three years age	..	20·0 ,,
(7) Female young stock under three years age	..	20·0 ,,
	Total	140·0 ,,

Editor's note :

Dr. Makhijani seems to ignore the effect on the number of cattle needed of the possible use of improved implements. We hope to have an article in an early issue dealing with this. It seems to offer the opportunity of considerable saving in cattle power.

The Editor.

THE DOCTRINE OF AHIMSA AND CATTLE BREEDING IN INDIA*

BURCH H. SCHNEIDER

Professor Schneider (Ph. D. Cornell, 1931), whose special interest is animal nutrition, was a representative of the Harvard Mission in Albania, 1927-29. He was at the Allahabad Agricultural Institute for five years, and is now Professor of Animal Husbandry at West Virginia University.

In examining the effect of the doctrine of *ahimsa* on cattle breeding in India, one must first understand its significance. This part of Hindu philosophy prohibits the killing of any animal life. It has far-reaching consequences: it has greatly affected the political policies of Indian nationalists and it is the basis of the non-violence movement, or *Satyagraha*. When Gandhi was taken to prison in 1942, his last instructions to his followers were: "Do everything possible under *ahimsa*..." His assassination may be interpreted as a revolt against this ancient doctrine, which he practiced and advocated. A group of Hindus wanted to fight the Mohammedans, but the Mahatma, who proclaimed *ahimsa*, stood in the way.

The doctrine has its roots in the belief in reincarnation. The orthodox Hindu abhors the idea of killing an animal because he believes it might have the soul of a man from a previous incarnation. The taboo applies most strongly to cattle and to certain other species of animals. The modern Hindu points out that the early lawgivers provided protection for cattle and gave the rule religious significance in order to preserve this essential draft animal. The farmers of India are dependent on their oxen for plowing and all motive power in cultivation. It is reasoned that the ancient wise men thought that in times of drought and famine a flesh-eating people might kill all their cattle for food; then when the rains came again they would have no oxen to cultivate their fields.

Whatever the origin of the doctrine of *ahimsa*, it must be taken into consideration in any plan for general livestock improvement in India. There are few countries in which the lives of the people are so closely associated with their cattle. Approximately one-third of the cattle of the world are in India, and, in many sections of that densely populated country, the number of cattle closely approximates the

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human population. These humped Brahman, or Zebu, cattle have been imported in large numbers into the Western Hemisphere, and they are rapidly increasing in almost all tropical and semitropical climates because of their ability to survive, and even thrive, under difficult environmental conditions to which other breeds succumb.

Western observers have been outspoken in their condemnation of the doctrine of *ahimsa* and its effect on cattle breeding in India. One world authority on livestock breeding told me that he had refused a position in India because he understood that the people would not kill their inferior animals. Thus, he concluded, he could do little professionally, and it would be useless for him to go there. Even among leading Hindus, one can recognize a note of hopelessness with regard to cattle improvement. Although they may be committed to the doctrine of not killing cattle, nevertheless with their background of education in Western practices in animal husbandry, they cannot conceal their conviction that the task of breeding improved cattle in a Hindu society is impossible. I have come across this attitude on many occasions in conversation with employees on government cattle farms, large landholders, and rulers of natives states—all interested in cattle improvement, but unconvinced that it is actually possible under India's socioreligious system.

I have been tempted to concur in the outspoken opinion of some other Westerners that the best way to breed improved cattle in India might well be to slaughter all of the poorest animals. Nevertheless, before one has lived many years in close harmony with Hindu cattle breeders, he ralizes that it will not be possible in our generation to begin cattle improvement in India by wholesale slaughter, or even by killing a limited number of the worst specimens. Contact with the Occident may bring greater "enlightenment," but one need not hope to see a willingness to kill excess inferior cattle in the near future.

The handicaps of the *ahimsa* philosophy are very evident. The possible advantages have never been pointed out. Breeders everywhere must consider the adaptability of their livestock to the climate, the feeding stuffs available, and the suitability of the animals for the purposes for which they are intended. Also, they must consider the habits, social customs, and economic conditions of the people for and by whom the animals are bred.

In India, cattle are bred for draft and for milk production. There has been no need to improve their beef qualities, since a large proportion of the population eat no beef. Hindus, Sikhs, Jains, and Parsis (Zoroastrians), which together compose two-thirds of the population of India, all respect the doctrine of *ahimsa*.

Some of the finest draft cattle in the world are to be found in India. It is evident that selection for draft type has been highly successful. To raise the general average of draft cattle, it has appeared to be necessary only to breed the small, less desirable cattle of some sections to the more drafty, improved types found in other parts of the country. The breeding of better cattle in any case must, of course, be accompanied by improved feeding and management practices in those areas that have previously had inferior cattle. Provision for good feeding is one of the imperatives of the livestock industry in India. The improved cattle should be well fed even though the others are denied enough to eat.

Indian cattle show less improvement in dairy qualities than in draft type. The average milk production of Indian cows has been estimated at 600 pounds per year. Milk is of the greatest importance because of the doctrine of *ahimsa*. Since meat eating is forbidden, milk becomes the only common food of animal origin that the religion of more than 200 million people permits them to eat. Furthermore, Indian people are very fond of dairy products of all kinds, of which they have several unknown to Americans. It is generally recognized that the proteins of animal origin average higher in biological value, and that such foods contain more minerals, particularly calcium and phosphorus, than most foods of plant origin. There are other dietary advantages of a mixed diet from both plant and animal sources that emphasize further the great importance of breeding for higher milk production wherever milk is the only animal product consumed by great masses of the population.

The greatest objection to the doctrine of *ahimsa* is found in the excessive numbers of cattle permitted to live and compete with other animals and with man for the fruits of the land. It is surprising to note the congestion of animal and bird life of all species in some sections of India, which are among the most densly populated parts of the earth. Throughout all seasons of the year, neither man nor beast is able to obtain an adequate food supply. For those engaged in cattle breeding as a business, it is obvious that the exces-

sive numbers of cattle tend to decrease their value, and the attendant shortage of cattle feed increases its price. These two factors make commercial dairying a difficult enterprise unless high-quality milk is sold at high prices in urban areas to Europeans or to well-to-do Indians. The millions of inferior and unproductive cattle that must be fed constitute a huge economic drain on the country.

Under present economic conditions in India few cattle owners have the means to purchase fence or to employ herdsmen to keep their cattle entirely separate from other, inferior cattle. In other countries, also, where public grazing grounds were formerly the rule, general improvement of cattle was not begun until laws were passed requiring individual owners to fence in their livestock. (Many countries having no taboos restricting the slaughter of cattle have fully as poor animals as India.) It is the custom, but not religious law, for all cattle in an Indian village to graze together. Poor cows, good cows, calves of all ages, scrub bulls, and government-approved bulls are all in the same herd. Fencing cattle is not as feasible in India as in some other countries, because each owner often has only two or three animals. Fencing materials are expensive, and the relative cost per animal would be exorbitant for the poor peasant.

Any attempt to improve livestock must have the full cooperation of the entire village. Education and confidence are necessary. When public sentiment swings in favour of any reform, pressure may be brought to bear on backward individuals in India as effectively as in any other country. It is not necessarily inherent in the Hindu system that inferior cattle be permitted to propagate themselves promiscuously. Social custom, not religion, has permitted promiscuous breeding. It is possible to remedy this defect without violating the Hindu conscience.

Cattle improvement may be undertaken from either the lower or the upper end of the scale. In Western countries we have raised the average of our cattle by culling the poorer individuals. We have culled our cattle almost invariably by killing them. This is, of course, very effective in making changes quickly in the average merit of any group of individuals. Consequently, our thinking regarding cattle breeding is such that most of us have the idea that this is the only way to improve cattle. Actually, this kind of mass selection is not very effective in producing better cattle, i.e., in improving animals at the upper end of the scale.

The excellent work in culling at various government farms in India illustrates the effect of culling the poor cows. It has been the custom on such farms to measure progress in breeding for milk production by the average daily milk yield per cow. Improvement of this kind, however, is not a function of breeding, other than that replacements in a herd are obtained from among offspring of cows remaining in the herd after culling. It is possible to increase the average by discarding the poorest producers year by year, yet breed no better cattle. There is evidence that this occurs. For instance, there are records of Indian cattle producing 7,000 pounds of milk per lactation thirty years ago, yet as late as 1932 no better yields had been obtained by breeding. Since that year, changes in feeding and management have resulted in increases in production not due to breeding. Culling out the poorest cows raised the yearly averages of a herd, but did not breed better cattle.

Our Hindu brother, who is pessimistic regarding the improvement of cattle in his country because of a fundamental religious philosophy that he is reluctant to give up, may well ask: "What is accomplished by 'murdering' cows?" For each inferior cow killed, we prevent the birth of an average of less than one inferior calf annually. This practice, therefore, which is opposed to *ahimsa*, if carried out wholesale, reduces the numbers of existing inferior animals, but it is not as effective in preventing the propagation of inferior cattle as another practice : castration. Castration can be far more effective in reducing the numbers of poor calves. A scrub bull may sire twenty or more scrub calves per year. Castration is not as offensive to the religious sensibilities of the Hindus as the killing of cattle. It is well known and is practiced in all parts of India. Although there might be difficulty in carrying out wholesale castrations in certain parts of the country, I am of the opinion that there is no part of India where general castration of scrub bulls cannot be introduced, especially if the cooperation of intelligent leading Hindus is obtained. The use of the "bloodless" Burdizzo castrater is particularly helpful in dealing with peasant prejudice. Castration *is* practiced widely. Where it has been objected to on religious grounds, this has been only an excause advanced by Hindus who did not understand the program to improve their cattle, and who were fearful of the consequences. Without understanding, they might well fear the possibility of being left without adequate numbers of breeding bulls.

Hinduism is not opposed to selection of cattle with the viewpoint of increasing the number of progeny from superior bulls. *Ahimsa* is opposed only to killing ; it is not opposed to castration. It is not opposed to selection if it can be practiced without "murdering" cows. Our Western practice of slaughtering cattle culled from breeding herds has made culling, killing, and herd improvement appear inseparable.

It is possible to practice selection by means of castration, and permit superior bulls to sire more calves, without coming in conflict with Hindu religious thought. In fact, *ahimsa* permits the more accurate selection of superior bulls than is possible in Western countries. The progeny test has proved itself particularly valuable in recent years with dairy cattle. The increased use of proved bulls is the goal of dairymen throughout the United States. However, it is recognised that many bulls may be rated more favourably than they deserve because their inferior offspring have been slaughtered. This difficulty would never occur in a Hindu community. All heifers strong enough to mature and produce milk are permitted to do so. None would be eliminated without having had an opportunity to obtain a measure of her milk producing ability. Furthermore, a measure of longevity of production and longevity of life of certain families might be obtained from the records, as no cows are killed even when they are past the age of economical production.

The practice of having public bulls at stud in India would supply the machinery for progeny testing in a way not found in many other parts of the world. It has long been a custom for a Hindu gentleman to honor a deceased relative by giving a bull to the community for public service. It is said that formerly superior animals were given, but it appears that the customs has now degenerated so that only cheap, inferior bulls are purchased and dedicated to the honor of the dead. This function of supplying bulls for public service has largely been taken over by the local governments.

It would be possible to maintain liaison between the peasant breeders and the central breeding farms that supply the bulls. The bulls should be used only in one-bull herds to prevent uncertainty regarding paternity, and they should be moved from time to time to prevent their breeding their own daughters. Bulls may be passed on to other villages or, if they have sired superior offspiring in the villages, returned to the central breeding farm as proved sires. All scrub bulls running in the same herds should be castrated. It is also

possible that such a well-organized scheme might achieve sufficient prestige in certain areas that service could be refused to inferior cows.

Certainly, tremendous effort and great leadership would be required to launch a comprehensive system of cattle improvement based on progeny testing in the villages surrounding even one cattle-breeding farm from which bulls are supplied. I know of only one such attempt having been made. The plan is entirely feasible, however. Every Indian village has at least one literate man who, with proper supervision, meticulously keeps certain village records. It is far from impossible to conceive of such a man maintaining accurate breeding, production, and other records necessary for progeny testing. Thus, bulls could be regularly proved in all the villages in the area. It is important that such a local area be saturated with good breeding bulls. Such a plan is better than spreading the available bulls out thinly by scattering them over an entire province. It is also desirable that such an area be near the farm on which the bulls are bred. It is possible that progeny testing may not be effective in the beginning if the native cows are very heterogeneous. This is a difficulty that will be progressively overcome, however, generation by generation, as bulls of similar breeding are provided.

Cattle could be improved by breeding the best better. Improving the cattle at the central breeding farm would in turn enable better bulls to be supplied to the villages. Culling and killing of poor individuals would not be a requirement of this plan, for all offspiring of every bull would be permitted to live as complete samples of all progeny capable of survival. Proper recording and application of genetic principles can go far toward making the best of a bad situation. Selection would take place on the basis of these samples of germ plasm more complete than anywhere else in the world. Improvement would take place at the top, not by eliminating the lower-producing individuals. Such a system could operate as economically and effectively in India as in any other country, with many points in its favor.

Although the doctrine of *ahimsa* is a handicap to phenotypic selection as practiced in Western countries, where inferior cattle are culled and killed, it appears to be of value to genotypic selection and the breeding of superior animals, provided good records are kept and genetic principles followed. Occidentals consider *ahimsa* a great disadvantage from the

Western point of view, but it need not be an unsurmountable obstacle to cattle improvement in India. Newer practices of progeny testing may be carried out more completely in a Hindu society than where there are no inhibitions regarding slaughter of cattle. Genotypic selection for milk production may then be found to be more effective by not practicing close phenotypic culling of both sexes. This should be a challenge for agricultural officers in the newly created Dominion of India.

FLOWERING AND FRUITING HABIT OF ASPHODELUS TENUIFOLIUS.

By

[B. S. Fozdar and S. N. Singh.]

Asphodelus tenuifolious is one of the commonest weeds of the Rabi season, present practically in all the wheat, barley and other Rabi cereal crops. It is necessary to know the fruiting and flowering period of a weed to be able to control it effectively by performing minimum number of weeding operations.

Weekly observations on flowering and fruiting of the weed were made as given in Table No. 1. An average of 20 plants was taken.

TABLE No. 1.

(Average of 20 on each date)

Date of observation.	Average number of branches per plant.	Average fruits per plant.			Open flowers per plant.	Closed buds per plant.	Total flowers per plant.	Height of the weed in inches.
		Immature.	Matured.	Dehisced.				
27th January, '46	3·1	9·5	..	..	2·2	39·5	51·8	..
3rd February, '46	5·2	28·9	..	..	5·0	69·3	103·2	..
10th February, '46	5 4	67·6	..	..	2·3	22·9	92·8	..
17th February, '46	5·4	73·4	..	..	1·7	23 0	98·1	15·1
24th February, '46	5·6	70·0	5 8	..	1·5	20 8	93·1	14 2
3rd March, '46	4·7	42 0	10 9	..	0·5	0 5	53 6	13·6
10th March, '46	3·1	9·5	26·8	..	..	1 3	37·6	12·6
17th March, '46	5·0	4·9	13·4	62·3	0·3	2·2	83·1	15·7
					Total	..	612·8	
					Mean	..	76 6	

On an average the flowering commenced in the month of January. The average number of fruiting branches successively increased up to a maximum of 5·4 per plant during the second week of February. Though immature fruits were observed as early as the last week of January but they did not mature until after the 3rd week of February. The maximum number of mature fruits was noted on 10th March, 1946, but so for dehiscence did not occur. The dehiscence of the fruit was confined practically to the subsequent week only, after which a few matured fruits remained to dehisce.

The average number of fruiting buds per plant was 76·6 while the average number of seeds per plant was 456 (An average of 20 plants, representing different stages of growth within the field was recorded).

Thus if the field is weeded just after the appearence of maximum number of immature fruits that is in the 2nd week of February, and the operation is completed by the 3rd week of February, the weed can be effectively controlled for the subsequent year.

ENGINEERING AND POPULATION PRESSURES*.

When the American Association for the Advancement of Science celebrated its centenary in September, it showed notable intellectual concern and a sense of moral responsibility for growing problems of population pressures. In reporting this phase of the meeting, "Time" used appropriate exaggeration to emphasize the point succinctly by heading its item "Standing Room Only."

Fairfield Osborn pointed out that "Within only three centuries, the population of the earth has increased five times. .... It is now increasing at a net rate that, if continued, would double the earth's population again in another 70 years."

In the words of Warren S. Thompson, "Since the middle of the 18th century, the population of Occidental lands has undergone a growth in numbers and a change in distribution which ...... is unprecedented. These revolutionary changes .... are for the most part by-products of scientific knowledge .... Pushed to it, we are endeavoring to develop new means of sustaining human life....... If man continues his unthinking exploitation, it will take more than a research chemist to insure survival."

What these scientists are saying is that, on a finite planet, increases in population and their use of resources cannot correctly or safely be considered as mathematical progressions which will continue to infinity. Neither can it be expected that a level will be reached painlessly and without human effort. It is time to anticipate that human population can reach and temporarily exceed the supporting capacity of the earth. Population will be limited by moral force, or by biological forces such as hunger, war, and pestilence, or by both.

During much of the period since Malthus pictured this problem more than 100 years ago, his theory has been largely discredited. Science, engineering, and industry have increased production of the physical means of living even more rapidly than the population has increased in Occidental lands. The direct result has been an improvement in levels and standards of living.

But this has been accompanied by large-scale exploitation of exhaustible resources. Even assuming the full potential

*Reprinted from *Agricultural Engineering*, November 1948.

development of substitute resources, synthetic materials, and economic large-scale recovery and reuse of important materials, it is difficult to see how production can keep ahead of population increase for very much longer.

The development and popular acceptance of new concepts of the relative moral and humanitarian merits of alternative quantity or quality living may be a slow process. Meanwhile population will continue to increase. Engineers can anticipate that the increase may complicate their working conditions as well as their subject matter.

With reduced elbow room and freedom of action, engineers will be called upon to further improve utilization and conservation of the forces and materials of nature, for the benefit of more people, over longer life spans. In doing it engineers will be required to deal effectively with the physical aspects of congestion, its transportation bottlenecks, sanitary hazards, and conflicting interests in the use of limited space and resources, to name a few.

Agricultural engineers will be particularly concerned because of their close association with the basic production of food and fiber necessities, with resources which can be conserved and renewed to a greater extent than many other resources, with farm needs for space in which to operate most efficiently, and with the farm source of much of our population increase and best leadership.

'MILK AND METALS.'

By

E. C. Peter.

When milk is processed it naturally comes in contact with different metallic surfaces and as different ranges of temperature, so it is important to know the effects of milk on metal and *vice versa*. The continuous contact of milk with the metal in the parts of processing plant slowly increases the amount of heavy metal in the milk ; it is specially found in the case of copper and iron.

Now the factors to be concerned in the choice of metals best suited for dairy utensils and plants are as follows :-

Firstly.—the metal must be strong enough to give good service and to stand up to the ordinary wear and tear of regular use.

Secondly.—The metal must have such properties as malleability, capacity to be pressed or cast into a desired shape.

Thirdly.—It should solder and weld easily and should be strong in their sheeting.

Fourthly.—It should be a good conductor of heat, which is specially useful for pasturising and cooling processes.

Fifthly.—The surface should not be corroded by milk or its acid by-products. It must be durable and resistant to the actions of brine, soap and other alkaline detergents in the regular process of washing and cleaning of the utensils and plants.

Sixthly.—That the metal should not add traces of any poisonous material to the milk by coming in contact with it. It is also seen that the metals like zinc, lead, and antimony shorten the keeping quality of the milk.

From the engineering stand point plated copper has been very successful while aluminium and stainless steel are also extensively used. Besides these properties of the metal there should be some stress laid on the appearance of the utensils and the use of untarnishable metals for tanks, pipes, etc., has to be considered. This introduces another problem of the

action of milk and its by-products on such metals as nickel, and tin plating on steel and copper. The problem of storing large or small quantities of milk comes before the storage of its by-products, because the by-products of milk are manufactured in very little quantities. The transportation of milk being very difficult in the present times makes it more important to be stored for a while. So to overcome this difficulty, the use of aluminium, stainless-steel and glass-lined tanks has been made.

Since the storage qualities of both milk and its by-products have been found very closely associated with the contamination by the heavy metals, specially where the fats are concerned, the corrosive action on the surface of the metal needs careful consideration. For this reason tin is supposed to be the metal which is least corrosive and is good for plating in dairy work.

Most of the wear and tear of the metals of the utensils is due to the treatment of handling and washing of them by means of brushes and by the use of detergents not rather than due to the solution by liquids as hot water and milk.

Now let us deal with an individual metal at a time.

Firstly Copper.—Copper, owing to its mechanical and physical properties, has been found to be excellent for the use in dairy plaint only after it has been plated with a resistant metal. Copper is readily dissolved by milk and its by-products, except cheese, and the solubility of copper helps in the oxidative changes of fat in the by-products. The other various effects of copper solubility are that if the milk or its by-products have small percentage of acidity it does not dissolve so readily as it would if the acidity were increased. Copper appears to be less soluble in skim milk than in whole milk. Also the boiled milk which has been cooled, has less effect than raw milk.

So the parts which are made of copper or copper alloys and which are exposed to the milk directly add their little amount of copper to milk. These parts are mostly brass taps, strainers, coolers, milk bottling machine etc.

The second metal is Aluminium.—Aluminium owes a great deal to its lightness in weight, cheapness, purity and other mechanical properties. Nowadays it is being used extensively for the manufacture of dairy plant specially storage vats

and other utensils. The amount of metal dissolved is very little compared to what amount of copper and other metals. Even the sour milk does not have much effect on it. It ranks with chromium steels in its resistance to corrosion and there is very little effect like tarnishing on its surface. Wrought aluminium is more resistant to corrosion than cast aluminium because it is more pure. The only disadvantage about aluminium is that it is quite a soft metal and wears off quite quickly and is damaged by rough handling. The other properties of the alloys of aluminium with manganese and magnesim called magnalium are much harder and are worn out less quickly. Aluminium bronze alloy corrodes considerably and aluminium alloyed with copper improves the physical properties but at the same time the other qualities make it impracticable for dairy work. The main drawback of aluminium is its lack of resistence to alkalis, specially at hot washing temperature.

The Stainless steels are alloys of steel and Chromium and of steel, nickel and chromium. These do not tarnish in moist atmospheres. These may be classified into three classes of rustless and acid resisting steels. *Firstly* Plain Chromium steel. *Second* is steel high in chromium content and low in nickel content and third one is steel with high content of both nickel and chromium.

The plain chromium steel shows excellent resistance to corrosive action by the milk. The resistance to corrosion increases as the hardness of the steel increases. The power of conducting heat in stainless steel is much less than ordinary steel, therefore the stainless steel parts are used where the heat can be transmitted without much loss of effeciency.

Nickel and its alloys are not so common in dairy work. Nickel alone is much inferior to the alloys of nickel and chromium ; in the sense that the alloys are more resistant to the corrosion in milk under all conditions. Monel metal and nickel silver have proved disappointing in their resistance to corrosion and tarnishing, specially when they come in contact with acid milk products. These alloys also contain copper in small traces and cause a metallic flavour or an after flavour due to the effect of small amount of metal dissolved in the fat of milk or its products.

Tin Plated Steel. The greatest quantity of small ware used in dairy such as, pails, measures, vats, milk churns, etc., are made from tinned steel. The advantages are that it is cheap, it is easily built in shape, it stands well against corrosion by fresh milk. It is quite durable and will stand rough handling to quite an extent. The tin plating on steel differs from the tin plating on copper in that there is more alloying of copper with tin and it is less in the case of steel. It is evident that the resistance of tin plated iron or steel depends on the quality of tinning. Tin plated metals are generally less resistant to action by alkaline washing liquids than tin itself but tinned iron corrodes easily with solution containing free chlorine thus being inferior in this respect to tin and tinned copper.

Iron and galvanised iron are used for vessels which hold liquid milk by-products such as whey and butter milk. But these metal are definitely inferior for holding milk or cream for storage.

Chromium plating is not very lasting and as such is of inferior service. Therefore it is much better if it is used in alloys when the resistance to corrosiveness can be made use of.

Glass, enamel coated metal and wood. Glass or enamel coated materials which are used for dairy purposes are non-corrosive and are very hygienic. But as the durability counts a lot, such surfaces can only be used on thick steel sheeting which is handled very carefully, but still they are short in lasting.

Wood is extensively used for structural purposes and in direct contact with cream and butter in churns and butter workers. For churning wood surfaces must be treated specially so that butter does not adhere to them. For long service, only the hard woods are used for direct contact with the cream.

The effects of metals on milk and its products—are firstly that the milk gets a metallic flavour secondly that it gives oxadised flavours and thirdly that the addition of cumulative metals makes it a bit poisonous.

The metallic flavour is got by a number of heavy metals when dissolved in traces in the milk. The metals like copper and brass dissolve in smaller quantities and do not impart a flavour while aluminium, iron and zinc do give a metallic flavour. The metals that show definite corrosion generally have the most damaging effect on the flavour of milk and its products.

Metals as cumulative poisons—The amount of heavy metals which enter milk and its products intended for human consumption are not large enough to be physiologically significant. There is no accumulation in the human body, of the metals that may enter milk from dairy plant.

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THE ALLAHABAD FARMER

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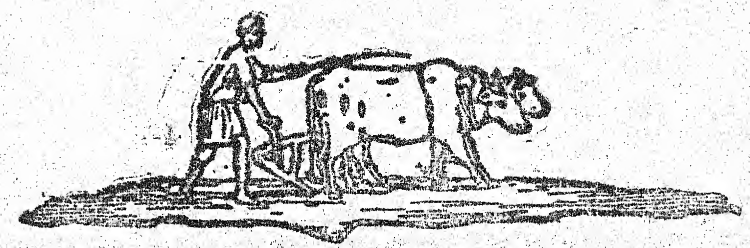

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OATH FOR SOCIAL WORKERS

I shall serve to the best of my ability the depressed, the handicapped and the needy.

I shall show no difference as to creed or colour or position of people in any personal or professional relationship.

I shall serve all the people I can, in all the ways I can, as often as I can and as long as I can.

I shall serve all equally and I shall try to develop such judgement and affection and patience that my service will heal ill-feelings and distress.

I pledge myself to compassion and words of kindness and friendly sympathy that will enter into the joys and sorrows of all who are needy or afflicted or erring.

I shall never lose my faith in the value of every human being and the capacity of man to change his ways of life and thinking.

I shall have respect for all with whom I work.

I shall keep secret the information entrusted to me by clients.

I shall not repeat or be influenced by gossip.

I shall endeavour to be always objective and honest and straightforward.

I shall struggle not to permit myself to become discouraged no matter how slow or how difficult the process and the progress.

I pledge myself to continue to study during my whole professional life the needs of human society and the best ways the world is learning of meeting them.

I shall share the problems and struggles of other social workers and I shall help their families as my own.

I shall bear my full share of responsibility for the organization and co-operation of welfare agencies wherever they are needed for betterment of living from childhood to old age.

I pledge myself to work for loyalty within my professional group. I will work also for extension of such loyalty to all men and women who have the responsibility of serving my country and my people in government or other official capacity.

I would serve my countrymen with all my heart, with all my mind and with all my might, realising the need of each one for social security and those opportunities which build the good life.

I shall look not back but forward until the goal is reached.

Let me serve my fellow-men. That is all I ask.

Originally written by the students of
the National Y. W. C. A., School of Social Work,
Delhi for Gandhiji on his birthday, 1947.

WIND, WATER AND FOOD

By Clifford C. Taylor

Agricultural Attache American Embassy, New Delhi.

Famine stalks Saurashtra and adjoining areas. Food imports are being demanded in astounding quantities. Cattle are being moved out in search of fodder and train loads of fodder are being moved in to save those that remain. Wells are being dug to provide water. The tragedy of it is that when the monsoon failed and crops withered away there was enough water beneath the ground and enough wind above the ground to have saved much of the crops if windmills had been used to pump water for irrigation.

American Windmills :—In the United States, Canada and Australia one is accustomed to seeing windmills on the farm that are quite different from the picturesque Dutch windmills. The American windmill simply consists of a four-legged steel tower crossbraced with steel rods and wire, on top of which is a wheel, like a slowly turning many-bladed airplane propellor, geared to a rod extending down to a cylinder in the water in the well. A tail keeps it headed into the wind. It pumps water for the livestock, the home and the garden. Surprisingly, almost no windmills are used anywhere in India. The cost of a windmill is little more than the cost of the pair of bullocks used for lifting water ; and the windmill consumes neither fodder nor petrol nor electricity. Furthermore, it does not require any man to operate it, for it is automatic for as many hours as there is a breeze blowing.

Wind Power :—A wind of 10 miles per hour turning a wheel (mill) 12 feet in diameter and operating at 50 percent efficiency develops 0·2 horsepower. This power will lift 500 Imperial gallons per hour from a depth of 40 feet. It will lift 1,000 gallons per hour from a depth of 20 feet, which is more than a pair of bullocks would deliver by the use of the usual rope and leather bucket.

A windmill pumping 500 gallons per hour for 13 hours a day will deliver two inches of water to an acre of land within one week. Within 12 weeks of the year it would deliver more water to an acre than most of the irrigated land in India receives from irrigation in a year.

When the wind is low and the delivery of water is small, a small tank at the surface of the ground can collect the water until it can be drawn away at a high rate.

Strong breezes develop ever so much more horsepower than light breezes and large wheels capture much more wind than small wheels. A standard formula for measuring horsepower developed by windmills is: velocity of wind cubed, multiplied by wheel diameter squared, multiplied by the efficiency coefficient. In this formula the wind velocity per hour (as measured by a Robinson anemometer) is converted to feet per second by multiplying it by 1·466 and the end result is pointed off to six more decimal places. A 6-mile wind is 8·8 feet per second and a 12-mile wind is 17·6 feet per second. For example, the horsepower developed by a 6-mile wind and a 12-foot wheel with a 50 percent power coefficient would be 0·05.

$$8{\cdot}8 \times 8{\cdot}8 \times 8{\cdot}8 \times 12 \times 12 \times 0{\cdot}50 = 0{\cdot}05 \text{ H.P.}$$

The power developed by a 12-mile wind would be eight times as much.

$$17{\cdot}6 \times 17{\cdot}6 \times 17{\cdot}6 \times 12 \times 12 \times 0{\cdot}50 = 0{\cdot}39 \text{ H. P.}$$

But a small 6-foot wheel instead of a 12-foot wheel delivers only 36/144ths as much power; in this case only 0·01 H. P. with a six mile wind and 0·10 H. P. with a twelve mile wind. Similarly one can calculate with reasonable accuracy the horsepower developed from a given wind velocity by any size of wheel up to the very large 20-foot wheel.

Obviously, a 6-foot wheel is too small if irrigation is in view. By definition, lifting 33,000 pounds (3,300 Imperial gallons) one foot in one minute is one horsepower. If a windmill develops only 0·01 H. P. it will deliver only 2,000 gallons an hour, divided by the number of feet the water is lifted, *e.g.*, 100 gallons an hour from a depth of 20 feet. A wheel three times as large would deliver nine times as much water.

The size of the pump cylinder must be carefully selected, as indicated in the various manufacturers' catalogs, to give the proper load for the size of the wheel used, the number of feet the water is to be lifted and the prevailing wind velocity. If the windmill is equipped with a pump cylinder of the proper length and diameter to pump at its best in a 10-mile wind, the mill will run too fast in a 20 mile wind to develop its maximum power and too slow in a wind of less velocity. It probably will not run at all when the wind velocity drops to one-half. If the component parts of the windmill are not properly matched to fit the requirements of the case the horsepower efficiency may be no more than 30 percent of the theoretical force of the wind.

The Ministry of Agriculture in each of India's nine provinces as well as in New Delhi has a copy of United States Department of Agriculture *Farmers' Bulletin* No. 1857 (December, 1940) entitled "Small Irrigation Pumping Plants" which shows manufacturer's recommendations as to cylinder size and capacity when the wind velocity is about 15 miles per hour. For a 12-foot wheel it specifies a cylinder of 16-inch length, 8-inch stroke and $5\frac{1}{2}$-inch diameter for a lift of 25 foot or $3\frac{1}{4}$-inch diameter for a lift of 50 feet. At 20 to 30 strokes per minute this combination would lift 800 Imperial gallons per hour from a depth of 25 feet and almost 400 gallons from a depth of 50 feet. Few places in India, however, generally have a 15 mile wind. When the usual wind velocity is only 10 miles per hour the horsepower developed with a 12-foot wheel is only one-fourth as much and consequently the cylinder dimensions would have to be reduced to avoid overloading and stopping the wheel. The manufacturer's tables showing proper specifications for the usual wind velocity, lift and wheel size should be followed.

Winds in India :—The monthly Weather Review published by the Government of India shows average and normal wind velocity at 8 A.M. and 5 P.M. at hundreds of weather stations throughout India. Unfortunately, those hours are unsatisfactory for measuriug windmill possibilities because wind velocity is then much less than during the day. At Belgaum, for which hourly data is available, the monthly averages are two or three times as great as the average velocity at 8 A.M. and 5 P.M. recorded in the Monthly Weather Review. Nevertheless, these data give a rough indication of the places where more wind is obtained and the months when winds are strongest. Possibly part of the seasonal variation is due to the fact that the wind strengthens at an earlier hour and dies down at a later hour when the days are longer.

Normal wind velocity, miles per hour, at 8 A.M. and 5 P.M.

	Karachi	Rajkot	Sholapur	Bangalore
January ..	6·2	4·1	5·7	5·1
February ..	6·8	4·8	5·5	4·7
March ..	8·2	6·0	5·7	4·5
April ..	9·7	8·1	6·4	4·3

	Karachi	Rajkot	Sholapur	Bangalore
May ..	11·6	11·3	8·2	5·5
June ..	12·7	11·7	8·2	8·2
July ..	12·8	12·0	10·1	8·4
August ..	11·9	10·2	8·7	7·3
September ..	10·0	7·0	6·4	5·8
October ..	6·6	4·2	5·9	4·1
November ..	5·3	3·6	6·1	4·4
December ..	5·9	3·6	5·7	4·8

The records at hundreds of stations show that India has wind enough to operate American type windmills almost everywhere except in the Gangetic plains. The best places for windmills are in drought-stricken Saurashtra and almost anywhere between Karachi and southern Bombay Province. To this should be added parts of the coastal region along the Bay of Bengal and much of the Deccan plains and South India.

The Director General of Observatories in New Delhi has a government publication dated 1935, now out of print, entitled "Wind Data for Windmills". It reports experiments at Madras which showed that a steady breeze of about six miles per hour would keep a windmill in continuous operation pumping water from a depth of 25 feet. Even a four-mile breeze at Coimbatore pumped enough water for domestic purposes. The size of the windmill was not stated. From a study of Indian wind data it was concluded that there was a wide field in India for the profitable use of windmills for lifting irrigation water.

In the more detailed basic data for 14 points in India with wind velocity recorded every hour several other favorable facts may be found. Wind velocity is generally greater during daytime when it is most convenient to irrigate the crops. There is generally more wind during the hot months preceding and at the beginning of the monsoon rains when it is most important to get the crops sown and growing, and there is scarcely a month without sufficient wind to justify a windmill except at four of the fourteen stations (Lahore, Agra, Jubbulpore and Calcutta).

Windy days and windy hours during year Average of five years.

Station	Days with wind blowing at least 6 miles per hour for 10 or more hours	Hours of wind blowing at least 7 miles per hour
North India—		
Dhubri (Assam) ..	91	2,190
Saugor Island (South of Calcutta)	263	5,782
Calcutta (Alipore) ..	40	1,051
Allahabad ..	116	2,628
Agra ..	40	1,139
Lahore ..	29	1,051
Karachi ..	329	6,833
Deesa (Southeast Rajputana) ..	226	4,643
Jubbulpore ..	69	1,752
South India—		
Bombay ..	223	4,468
Belgaum ..	307	6,132
Bangalore ..	248	5,081
Madras ..	182	3,767
Kodaikanal ..	212	4,380

As there are 8760 hours in a year, a windmill that pumps water only 25 per cent of the time would be pumping over 2,000 hours. No bullocks put in that much time at the well in any year. Yet at Belgaum there is wind enough to pump water for over 6,000 hours a year, at Bangalore over 5,000 hours and even at Allahabad over 2,600 hours. There would be an effective wind for at least ten hours a day on 307 days of the year at Belgaum, on 248 days at Bangalore and on 116 days at Allahabad. Wind power at Karachi is even more than at Belgaum.

Winds of 15 miles per hour or stronger, according to the weather records, are to be obtained for at least 1,000 hours per year at Saugor Island, Karachi, and Belgaum, but almost never at Calcutta, Agra, Lahore, Jubbulpore, Bangalore and Madras.

On the other hand, too much should not be expected from wind power. If the required flow of water is as much as 400 cubic feet per hour (about 20 acre-feet per 2,000 hours) or if the lift is much over 50 feet, one should wait for electric power to be installed or wait for engine fuel to become available.

Windmill Prices:—Windmills are not very expensive. The factory price of a 40-foot windmill tower in the United States is now about $150 and the price of the wheel and accessories ranges from about $100 for the 6-foot size to about $300 for the 12-foot size. It is generally recognized that if much water is to be pumped it is false economy to install the small wheel and the tower has to be tall enough to get the full benefit of the wind without being obstructed by trees or buildings.

Conclusion:—For lifting irrigation water from wells or tanks for India's typical farms of only a few acres a windmill would be much more efficient than a pair of bullocks, attended by one or two men and drawing up one leather bucket full of water at a time. Windmills could deliver more water for producing more food and the cost of operation is negligible. Bullocks now cost a lot of money and feed for them is scarce and costly. For other farm work most of the bullocks have to be kept anyway, but on farms of over 10 acres the extra pair of bullocks would not have to be kept and those that are kept would not have to be fed so much when not working at the well. In any case, does a man with canal water refuse to use it just because he already had bullocks for plowing and hauling? The usefulness of windmills in India, where there is enough wind and the water table is high, seems not to have been recognized.

IMPROVED VARIETIES OF BARLEYS

By M. P. Singh and R. H. Richharia.

The acreage under barley on the average of 10 years from 1933 to 1943 approximates 12,97,860 acres which is 53% of the average acreage going under the rabi creals in the Province of Bihar, and which is seven percent of the total cultivated area of Bihar.

The main use to which the crop is put in the province is its consumption either in the form of *satuu* or *roti* mixed with other grains such as gram or wheat or both. It acts as a secondary staple food for the poor in the absence of rice.

An appreciable quantity of barley is exported to foreign countries where it is used for making beer and of late quite a good quantity has started to be brewed in Indian breweries as well. Rusell, (1937)* has emphasized that a good malting barley, commands a price much higher than that of barley suitable for food alone. Premiums of as much as 50 to 100 % on the price of good malting barleys are readily available.

In Bihar attempts to evolve a barley suitable for food and malting purposes date as far back as 1933-34 and were being continued when in August 1942 all the research material was lost due to political disturbances. A fresh start had, therefore, to be made by collecting barley samples from various places in the province through the Deputy Directors of Agriculture. Side by side attempts were also made to look into the possibilities of introducing a barley type from other provinces *viz.*, United Provinces and the Punjab. Samples of improved barley from the above provinces were, therefore, obtained and tried.

In the absence of any suitable barley variety *I. P.* 13 and *I. P.* 21 were being cultivated in the province as the recommended varieties of the Department but both of these varieties were associated with one shortcoming or the other. *I. P.* 13 was characterised by possessing deep purple pigment in the unripe grain stage and was thus not suited for malting though considered residant to smut, but in seed yield it was not very satisfactory whereas *I. P.* 21 besides the deep purple pigment was susceptible to a large extent to smut attack although it was a fairly good yielder. It was, therefore, deci-

* Russel. J. Sir, 1937 Report on the working of Imperial Council of Agricultual Research in applying science to crop production in India.

ded that a barley type better yielder than *I. P.* 13 free from purple pigment and resistant to the smut attack would be a distinct advance. Concurrently attempts were also made to evolve a better malting type compared to *I. P.* 13. The requisites for a good malting barley are low nitrogen percentage, fine white mealy interior of the grain when cut across and the grain should be bold, plump, uniform in size and colour. These characteristics were also kept in view at the time of making selections.

A foundation stock of single plants was built up in the year 1942-43 from the samples collected from within the province and other places and were subjected to gradual shifting of superior forms by selection both between and within strains by progeny row breeding. Seed yield testing was first commenced with nine progenies of single plants considered promising, in the year 1944-45, and five strains were discarded at the end of the season. In 1945-46 seed yield testing of the four strains was made in replicated randomised blocks at the Central farms of the three ranges, *viz.*, Patna, Tirhut and Bhagalpur where barley of the province is mainly grown.

In 1946-47 and 1947-48 seed yield testing in replicated randomised blocks was done in most of the farms of Patna, Bhagalpur and Tirhut Ranges. The results arrived at are produced in Table I. In order to maintain purity of the strains for various characters, progeny row breeding was followed up concurrently and pure seed for trial purposes was supplied to the various farms year after year.

Inspection of Table I shows that most of the sectional strains are superior to the control in the various environments and seasons. The data are presented from 27 trials in most of which the differences observed in seed yield are significant, so that the differences can be relied on as representing real differences between the strains.

In so far as malting quality is concerned, judged by the Nitrogen percentage Table II, the sectional strains campare favourably. Besides, all the four strains are earlier to flower compared to the control and as such they escape being dessicated by the west winds should the latter happen to start earlier and thus they are saved from setting poorly developed grains. The advantage occurring, therefore, on the average of once every three years due to enhanced seed yield, not taking

into consideration the premium for quality, is nearly, 21% after taking into consideration the performance of the strains under various environments. As a plant breeding project, therefore, the work under discussion is amply justified.

The strains have been described below showing their morphological and other characters.

Strain Nos.	No. of rows	Colour of Palae	Rachilla	Glumes	Ear shape	Grain when unripe	Grain colour	Grain size, and interior
22	Six	White	Long hairy	Hairy	Fusiform	Green	Straw colour	Bold and mealy
24	"	"	"	"	"	"	"	"
27	"	"	"	"	"	Purple lined with flush	"	"
30	"	"	"	"	"	Purple streak	"	"

ACKNOWLEDGEMENTS

The help received is gratefully acknowledged from the Deputy Directors of Agriculture, Tirhut, Patna and Bhagalpur ranges who afforded facilities in conducting the trials on the Farms under them, from the Agricultural Chemist and Officer-in-charge, Nutrition Scheme, Patna, who analysed the samples from the chemical point of view and from Mr. Fazey Bari B. Sc. (Ag.) who worked in the section during 1943-44 with Mr. M. P. Singh.

TABLE I

Barley seed yield in mds. per acre of different improved varieties

	North Bihar						South Bihar					
	Musheri	Laheriasarai	Pusa	Purnea	Sepaya	Siwan	Sabour	Monghyr	Jamui	Patna	Nawadah	Bikramgunj
1944-45												
22 ..	..	..	..	..	..	..	23·4	..	..	..	..	..
24 ..	..	..	..	..	..	..	24·1	..	..	..	..	..
27 ..	..	..	..	..	..	..	27·2	..	..	..	..	..
30 ..	..	..	..	..	..	..	24·9	..	..	..	..	..
Local (I. P. 13) ..	..	..	..	..	..	..	17·8	..	..	..	..	..
1945-46												
22 ..	..	..	17·1	..	..	..	18·2	..	..	2·9	..	..
24 ..	..	..	16·3	..	..	..	19·3	..	..	4·0	..	..
27 ..	..	..	16·1	..	..	..	18·0	..	..	2·8	..	..
30 ..	..	..	13·3	..	..	..	16·8	..	..	2·8	..	..
Local (I. P. 13) ..	..	..	12·7	..	..	..	13·3	..	..	1·2	..	..
1946-47												
22 ..	..	21·6	14·6	1·5	10·4	23·1	23·3	15·8	0·9	1·1	7·0	3·8
24 ..	..	23·6	20·3	1·5	13·3	21·5	21·9	15·0	09	1·3	5·7	3·8
27 ..	..	21·0	17·6	1·3	10·6	19·8	19·7	14·8	0·9	1·0	7·3	3·8
30 ..	..	20·8	16·9	1·7	11·1	18·5	16·3	15·5	1·4	0·8	7·0	3·5
Local (I. P. 13) ..	..	17·2	17·8	1·3	11·5	17·2	16·2	15·2	0·7	0·5	4·6	3·4
1947-48												
22 ..	4·35	28·31	11·56	2·14	16·48	28·95	6·29	13·50	3·78	5·61	6·05	4·60
24 ..	4·57	28·07	9·67	2·40	17·89	28·42	4·47	14·36	2·92	5·42	4·54	4·88
27 ..	4·44	28·13	9·87	2·13	19·43	27·16	4·76	14·62	2·77	4·76	3·40	4·33
30 ..	4·62	25·42	11·09	2·65	19·02	23·91	6·36	15·62	2·42	5·54	4·73	4·55
Local ..	4·89	27·01	9·40	2·02	17·91	25·58	6·75	14·62	2·33	4·35	3·21	4·33

Table II

Commercial characters of Barleys 22, 24, 27 & 30

Strain No.	No. of trials	Mean seed yield in mds. per acre	No. of days between sowing and 1st flowering	Nitrogen % *	Food value** Moisture	Food value** Protein	Food value** Phosphorous	Food value** Fat
1944-45								
22 ..		23·4	60·3	..	..	..	..	..
24 ..		24·1	57·3	..	..	..	..	..
27 ..	1	27·2	65·0	..	..	..	..	..
30 ..		24·9	61·0	..	..	..	..	..
I. P. 13 ..		17·8	70·7	..	..	..	..	..
1945-46								
22 ..		12·7	60·5	..	..	..	..	..
24 ..		13·1	59·5	..	..	..	..	..
27 ..	3	12·4	64·8	..	..	..	..	..
30 ..		11·4	60·7	..	..	..	..	..
I. P. 13 ..		9·1	68·0	..	..	..	..	..
1946-47								
22 ..		11·2	76·0	1·58	10·6	6·06	0·318	0·41
24 ..		11·7	70·2	1·75	10·6	7·06	0·254	0·42
27 ..	11	10·7	76·0	1·71	9·8	5·68	0·351	0·38
30 ..		10·3	76·0	1·79	10·3	7·85	0·43	0·39
I. P. 13 ..		9·6	91·0	1·81	..	..	..	..
1947-48 ..								
22 ..		10·97	..	..	..	..	..	..
24 ..		10·63	..	..	..	..	..	..
27 ..	12	10·48	..	..	..	..	..	..
30 ..		10·49	..	..	..	..	..	..
Local ..		10·20	..	..	..	..	..	..
Average strains ..		11·31	..	..	..	..	..	..
Control ..		9·33	..	..	..	..	..	..
% increase .		21·3	..	..	..	..	..	..

Observations on flowering were confined to the experiments conducted at Sabour only.

* Determined by the Agricultural Chemist, Bihar, Sabour.

** Determined by the Nutrition Officer Bihar, Patna.

A NEW WINNOWING FAN OR BLOWER

By Mason Vaugh A. E.

Allahabad Agricultural Institute.

In the past several attempts have been made to supplement or replace the blanket or sheet, waved by two men, as a source of wind for winnowing the grain when natural breeze fails. Long ago grain graders or grain dressers, combining a fan and sieves somewhat like the cleaning shoe of the threshing machine were imported as possible devices for this. These however, were originally designed for grain dressing after threshers driven by power had done the preliminary winnowing or separation of most of the chaff and *bhusa* from the grain. Neither the imported ones or those made in India of the same pattern have proved really successful. They are not designed to handle the amount of chaff present, they tend to get out of order and are difficult to repair in the villages and are costly in first cost.

Some 20 years ago, about 1930, several mistries at various places in the U. P., and possibly elsewhere, made fans which were generally similar to the blades of ceiling fans but were driven by hand crank through cycle gears and chains. These had some popularity but were most often made on wooden stands which tended to get out of order, to be eaten by white ants or to rot, and the chains and other cycle parts were a temptation to cycle thieves and sometimes to owners. It was always a temptation to take the parts intending to "replace it before next harvest". Recently with the high price of parts and their scarcity, the cost made them unattractive and they have not come into province-wide village popularity.

More recently the Agricultural Engineer to Government, Bombay, has made a similar fan but with cast iron spur gears in a cast iron frame and made for mounting on a post set into the ground in such a way that the fan could be turned in the direction the wind might blow at the time of winnowing. The latter is an excellent feature. However, in order to keep the price low, the gears are only cast, not cut so do not run smoothly and are somewhat subject to wear and breakage. The overall cost is high and no repairs can be carried out in the village.

Recently the Agricultural Institute Engineering Department has taken up the problem and has developed a new type, somewhat based on the Poona design. The fan blades common to all the different designs have been retained. They are mounted on a short shaft which runs in a single plain bearing with a

V-pulley on the other end. A second V-pulley, much larger in diameter, is mounted on a similar short shaft to be turned with a hand crank. The two bearings are mounted on a simple iron frame which can in turn be mounted on the upper end of a short wooden post set into the ground. The large pulley is some 16″ in diameter, the smaller one is 4″ in diameter, giving a ratio of 4:1. That means that for one turn of the crank and the big pulley, the fan shaft will turn 4 times.

In order to cheapen it as much as possible, and to facilitate repairs and replacements as easily as possible in the village, the drive from one pulley to the other is by a rope which is specially made. This rope can be made easily by anyone who understands the village method of making rope. A single strand of fairly thin rope or yarn, about 1/8″ or 3/16″ in diameter (ek suth ya der suth) is taken round two supports to give the length of rope finally needed. The length of the strand should be about 3½ times the length of the finished rope. The end of the strand may be temporarily tied to the strand where they meet. The other end is then used to wrap around the first to make a two strand rope as is made when two strands are twisted together in making a rope by hand. The part of the strand still remaining is then laid in between the two strands as is done in hand rope making to give a continuous circular rope of three strands with only two strands to be tucked under in the way a rope is spliced. This method gives a continuous circular rope with a very small enlargement at the joint. Good results are not had by cutting and splicing all three strands as this makes too large a joint. The rope may be made from cotton rope or from sann or hemp, any rope fiber that is in common use in the village.

Most ropes draw up when they become damp at night with dew and stretch when they dry in the daytime, thus changing length. To avoid difficulty with this, the fan has an idler pulley on a swinging arm to run on the rope belt between the two pulleys on the slack side. This is pulled against the rope by a spring so that it can accommodate itself to the condition of the rope, keeping it always tight against the pulleys.

Tests of the fan show that when turned at a reasonable speed, it gives a good breeze, quite sufficient for winnowing. Turning is quite easy, one man can sit comfortably and turn it with one hand, changing hands from time to time. One man is saved as compared to using a blanket and the breeze is

better. It can be used in the open to help any natural breeze or it can be used inside a shed when the *loo* blows so strongly that the *bhusa* is carried away. It makes winnowing possible in the early morning or late afternoon when usually there is little or no natural breeze but when the temperature is more comfortable.

Manufacturing arrangements are not yet complete and no final price has yet been fixed but it is hoped that it can be sold for approximately Rs. 50 each. This is subject to future changes in price and availability of material and labour. It is hoped that a few units can be available for supply during the 1950 threshing season.

VEGETATIVE REPRODUCTION OF JACK FRUIT

By S. N. Singh,

Assistant Professor of Horticulture, B. S. Fozdar,
Lecturer in Botany.

AND

Mahendra Singh,
Postgraduate Student in Horticulture,
Government Agricultural College, Kanpur.

Of the various problems connected with the culture of Jack fruit, (*Artocarpus integrifolia*, Frost.) vegetative reproduction needs special investigation. Variation in plants when propagated sexually is universally well known. Few are the fruit plants which reproduce their like by seed with any appreciable degree of certainty. Almost all our important fruit crops are propagated asexually. Unfortunately the Jack fruit which is of great importance in the plains of United Provinces is not commercially propagated by asexual method.

This undesirability in Jack fruit can be eliminated by evolving a suitable method of vegetative propagation. With this end in view, the different methods of vegetative reproduction which are in vogue were tried at the Botanical Garden, Government Agricultural College, Kanpur, during the year 1946-47.

So far little work has been done in this direction in India or elsewhere. In the year 1935, success by inarching in *Artocarpus* was reported by Naik, in South India in his preliminary investigations.

Out of all the methods of vegetative propagation tried, only gootee succeeded under local condition. The preliminary trials conducted in the year 1946 contributed about 30% success by gootee, which, however, succumbed after four months of their planting in pots. This initiated for a more elaborate trial in different months of the year 1947, employing different media for covering the cuts of various size. (For details refer table No. 1.)

TABLE I

Effect of different media and time on layered shoots.

Date	No. of shoot tied in		Success in		% Success in		Remarks
	Sand	Soil mixture	Sand	Mixture	Sand	Mixture	
29th February, 1947.	..	20	..	..	..	0	Dark brown shoots with cuts ranging from 2 to 2½ inches just enough to remove the bark were more responsive.
13th August, 1947.	10	10	3	.	30	0	
27th August, 1947.	10	10	6	1	60	10	
5th September, 1947.	5	5	3	1	60	20	

The diameter of the shoot on which gootee was tried varied from ½ to 2½ inches and the length of the cut to remove the bark ranged from 1 to 2½ inches.

In one set of experiments a soil mixture whose composition was ½ part sand, ¼ part garden loam, and ¼ part canal clay, was used for covering the cuts, while in the other set the cut was covered with pure sieved sand and tied with gunny bag cloth. When the roots emerged out of the first layer of sand subsequent coatings with leaf mould were given to cover the roots sfficiently and tied with gunny bag cloth each time. The gootee was kept constantly moist. To restrict the drain on the freshly formed roots, it was considered desirable to train the gootee to a single stem. The laterals were therefore removed.

Table No. 1 reveals the percentage of success obtained in different months under different media. In the month of February no success was recorded under any medium, while in the second week of August, only 30% success was achieved when sand was used as the covering medium. In the soil mixture, under similar conditions, success was nil.

The last week of August and first week of September appear to be the most suitable time for this operation because as high as 60% success under sand was obtained.

Only dark brown shoots with specific size of cut (2 to 2½ inches) attributed to higher percentage of success and significant deviation from the above resulted in failure.

When the roots emerged from the third layer of leaf mould after about two and a half months a notch penetrating to half the thickness of the shoot was made. A week after, another cut was given to finally remove the layers. Some of the layers were planted in pots and others in well prepared shaded nursery to note differential behaviour under these two ecological conditions. It was observed that the plants under both the conditions remained dormant throughout the winter. With the advent of hot weather the layers planted in the nursery started producing new vegetative buds, but their absence was conspicuous in those planted in pots. Later, the plants in pots started shedding their leaves and the stem began to dry thus resulting in their death. The plants in the nursery are still flourishing.

In the present investigation success by gootee or aerial layring was obtained only under specific sets of conditions. Any deviation from these resulted in a failure. When gootee was done on shoots nearly two three years old in the last week of August and first week of September with cuts 2 to 2½ inches long and sand as the covering medium, 60% success was recorded. The reason for the failure or poor success under conditions mentioned otherwise are multifarious and are probably as enumerated below :—

Since young shoots grow actively chances of adequate accumulation of carbohydrates are remote as compared to older ones, thus contributing higher succes in the latter case. Similarly when cuts of smaller sizes are made the callus establishes continuity of the bark so as to defeat the very purpose for which the rings are made as shown in plate III. It was also observed that the shoots layered earlier rotted due to longer exposure to rain, while those layered in the later part did not suffer from this handicap. After a certain period, however, the flow of sap becomes meagre as the bark slipped off with difficulty. The highest percentage of success of the gootee was therefore confined to the short period between the last week of August and first week of September, when these two factors were least operative. Suitability of sand as against other soil mixture for covering may be due to the better drainage it provides. The death of plants in pots was due to roots becoming pot-bound.

References :—

Khan, Fazlullah.—" Clones of jack fruit (Artocarpus integrifolia) ", Indian Journal of Horticulture, Vol. 4, 1946, Nos. 1 & 2.

Feilden, G. St. Clair.—" Vegetative propagation of tropical and sub-tropical fruits" Imperial Bureau of Fruit Production, Technical Communication No. 7.

Explanation of plats :—

PLATE No. I.—Gootee with emerging roots.

PLATE No. II.—Gootee with roots exposed.

PLATE No. III.—Callus formation.

PLATE No. IV.—Exposed roots of seven months old layer from nursery.

PLATE I

PLATE II

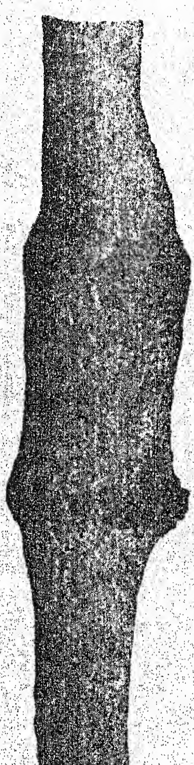

PLATE III

PLATE IV

BOOK REVIEW.

Food Problems in India in General and in Kolhapur St te in Particular.

By. Dr. P. C. Patil, published by Dr. Patil and available from Bhawanani and Sons, Connaught Place, New Delhi International Book Sellers, Poona 4, Cooperative Book Depot, Sir Vithaldas Memorial Buliding, 9 Bake House Lane, Fort Bombay and Bharat Book Stall, Gujari, Kolhapur. Rs. 4-8-0

Dr. Patil brings extensive experience as a Deputy Director of Agriculture and as professor of Agricultural Economics and experience as a member of a farming family to the preparation of the book.

The book is divided into 4 parts. The first deals with the food situation of the country as a whole, the second deals with more particular problems of Kolhapur state, the third deals with the problems and possibilites of increasing the food supply of the country and the fourth consists of appendices and supplementary matter pertaining to the rest of the book.

Dr. Patil very clearly points out certain fallacies in the old ideas concerning certain terms in use such as "fallow" and "culturable waste" and indicates that these terms are misleading in that the so-called fallow is really much of it grazing land and that the most of the so-called culturable waste is really the village common lands which provide grazing and fuel. He reaches the conclusion (on page 15) that "For the size and population of India, we do not think there is much scope for increasing the area under crops". He also points out the difference in terms as used in India and in the west, such as "holding" and "farm".

The problem of population is quite well dealt with and in relation to it, the possibility of increasing the proportion of animal products in the diet. The author reachesthe conclusion that, whatever the merits or demerits of animal food may be, the population pressure on land will compel the use of a predominantly cereal diet. He concludes that even fruit and vegetables may not be available for extensive use in the diet. On page 24 he says "In short, looking to the falling ratio of cultivated land in relation to population, it is necessary and desirable that India should produce more cereals and pulses than animal food. In other words, her diet should be composed mainly of food giving high calorie return per acre of land".

While the author deals very well with the present situation and its implications for the immediate future, he does not carry his analysis far enough. He shows that the present food production will need to be doubled by 1971 and very briefly indicates that this can in his opinion be done, mainly by increasing the yield per acre. He does not deal adequately with the situation which will arise in the years following 1971 when he seems to envisage that the major increase in production possible by presently known means will have been realised.

In spite of such shortcomings as the above, the book is a very valuable contribution to the scanty literature available on the food and population problems of India. It should be carefully studied by all officials dealing with policy in regard to agricultural development and production, by students of agricultural economics and by all others interested in these problems.

(PRESS NOTE)

ON

Draft Indian Standard On Wool For Export

By far the most urgent and important problem that confronts the Indian Wool-exporting industry to-day is the variability and, more or less, uncontrolled quality of the wool that is being sent out of the country. The adverse effect of such a procedure on the reputation and on the economic returns to the industry is fairly evident.

An effective remedy that would help the industry to grow on sound lines is to standardise the vari ous grades of exportable wool and to ensure that the exported product conforms to those standards. The importer abroad, being thus assured of uniform quality of wool in the respective grades, can confidently trade with the country, and will perhaps be ready to pay a permium for such assurance.

With these objects in view the Textile Division Council of the Indian Standards Institution has drawn up a draft Indian Standard Specification for Grading of Wool Export. This standard applies to wool produced in India, and specifies grades both according to colour as well as quality. Specifications for packing and marking are also included.

In accordance with the procedure of the Indian Standards Institution, every draft specification or code prepared by a Sectional Committee or Sub-Committee after its approval by the Sectional Committee, is to be issued in proof form for a period to be determined by the Committee, but not less than three months, and widely circulated amongst those likely to be interested, for the purpose of securing critical review and suggestions for improvement. Comments received from all quarters will be given due consideration by the Sectional Committee, and the revised final draft will then be put up to the Textile Division Council for endorsement. Before being finally accepted as an Indian Standard it must be approved by the Executive Committee and the General Council of the Institution.

This draft standard is being circulated among wool producers, exporters, manufactures and other interests who are likely to be interested in the subject of the standard. Comments will be received till the end of May 1949 by the Director, Indian Standards Institution, Block 11, Old Secretariat, Delhi 2.

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WHAT CAN AGRICULTURAL ENGINEERING DO FOR INDIA?

BY MASON VAUGH A. E.,

Allahabad Agricultural Institute.

Agricultural Engineering is the youngest branch of science associated with agriculture. It is defined as the application of engineering principles to the use of men and materials in the growing of agricultural, including animals and fruit, crops and in their utilisation. It is the applica tion of power and equipment to the solution of the problems and difficulties which the farmer meets all along his way.

We are all conscious of the very low standard of living of most of the people in India and there is a general desire to raise this more nearly to the world level. Since a large part of the population is engaged in agriculture, any general raising of the standard of living will involve raising that of agriculturists.

Man is a tool-using animal. Without his tools, he would be little better than any other animal; he would be reduced to foraging for wild food and dependent on what he could find. Man can consume only what he produces, that is, the standard of living depends on the productive ability of those doing the consuming. Overall productive ability is increased by a division of labour, by specialisation of different producers on certain lines

of production but the group, province, nation can consume only what it produces, including what it can get by trading part of its production for the production of others.

Productive ability depends on the tools used, the power controlled, and the intelligence applied to the work. The farmer's power may be that of his own muscles, that of his work cattle, or that of mechanical sources of power. His tools includes the land he works. The better the implements he has, the more the power he can utilise, the more land he can work or the better he can work a limited amount, the more he can produce. Of course the implements and power must be econmically utilised. Nothing is gained by "sending a man to do a boy's work."

Of course, the standard of living includes values other than what can be strictly called goods. Housing, home conveniences, liesure, and cultural facilities all contribute to the standard of living and to the richness of life even though they do not necessarily increase the capacity of the individual to produce "goods". The ability of the individual to produce above the bare necessities of subsistence determines the extent to which he and the group to which he belongs can have these other values.

Many people think of the work of the agricultural engineer as being concerned entirely or mainly with big machinery, tractors and their associated implements, combined harvester—threshers, big schemes generally. They say that India is a land of small farmers for whom such big things can have little meaning. Where then does the agricultural engineer touch the life of the small farmer?

The simplest plow, the *pharwa*, the *khurpi* even, is made of material and they each apply power to doing useful work. Each of them can be made crudely and work inefficiently or, they can be well designed, well made of the correct quality of material and will work correspondingly better as the design, workmanship and material is better suited to the job to be done. The better designed and the better made a tool or implement is, the better it fits the work it is made to do, the easier, the more effective the work of the operator, the more he can do in a given time or the sooner he can finish a given task. The selection of the right design and the right material and the manufacture of a *khurpi* at the least cost consistent with the desired utility, is just as much engineering as is the design of

a tractor. The tools and implements with which the Indian farmer now works are crude, ;they are made of the material and by methods adapted to primitive times, they take little or no advantage of recent technological developements which have made a wealth of better materials available. Their design and construction makes them time-consuming and inefficient in the application of the power with which they are worked. We need to apply engineering knowledge and skill to their improvement.

Transportation is a modern development. We travel in railway trains, ships, motor cars and aeroplanes, motor busses and cycle rickshas. Our food is moved from farm to market by transport. Does the farmer have a transport problem ? The preparation of a seed bed and the planting of the seed, is largely a process of *moving* soil. Interculture again involves *moving* the soil about. When the crop is ready for harvest, it must be cut and moved onto carts or by head loads and taken to the threshing floor or storage. It may be moved from threshing floor to farm store, again from farm store to primary market, before it starts on its real journey to the consumer. In fact the farmer is constantly moving—transporting—soil, crops, water, his implements to and from the field. He spends most of his time *moving* something. Engineered transport need not be only ships, trains, motor busses or aeroplanes. Engineered transport can ease the burden of the farmer also. Try to figure out the amount of grain alone which is now moved some distance in a ;year in India on the heads of the people. Transport on the farms in India presents special problems not found in the Western countries.

We think of processing of materials as a factory or workshop process or at least as a "cottage industry" process. Does the farmer have a problem of "processing"? Almost no crop is eaten directly as it comes from the field by man or beast. Grains have to be threshed and winnowed, fodder has to be chopped for the cattle, sugarcane must be crushed and the juice boiled to make gur, sann has to be retted and cleaned before the fiber can be used or sold for others to use. The farmer spends almost as much of his time in *processing* as he does in transporting. Engineering knowledge and skill has increased the productiveness of those working in factories and workshops many times. The farmer needs help from engineers to get the processing equipment which will best do his work under the conditions he has to face. It is the agricultural engineer who must do the development work on these things.

Soil and water conservation has had much attention recently. North India is gradually—and not so gradually sometimes when we consider the field of an individual farmer—moving into the Bay of Bengal or the Arabian sea. The development of soil saving structures, soil saving dams, terraces, are engineering problems. The development of cultural practices and the equipment with which to carry them out on the fields of the farmer is a job in which the help of the agricultural engineer is needed, a job as yet hardly touched in India.

But life is more than *things*. If we had all the food everyone wanted in abundance, if our soil were secure from erosion, if we had perfected implements to make our work easy and short, if we had adequate transport, but still had the villages as they now are, we would still have a low standard of living. Most so-called homes in India lack any sort of comfort or convenience. They afford inadequate shelter from heat or cold, rain or sun, rodents, insects or thieves. Many are hardly fit for human habitation, are incapable of being made attractive or comfortable. Architects and civil engineers are concerned with other problems. It is the agricultural engineer who is familiar with the needs and conditions of the villager, who has the engineering knowledge as well as the local knowledge to develop homes and other farm buildings which will give the maximum of comfort and convenience from the materials available and the cost that can be borne. These also are problems requiring the use of materials, the power to move and shape them.

The water supply of the village for domestic purposes is contaminated, difficult to get to the place of use, scarce in quantity and presents a problem of disposing of it after use. We are constantly exposed to the danger of infection because of the primitive way in which we dispose of human excreta. We are plagued by flies, mosquitoes and other insects. All these present engineering problems, problems dependent wholly or in part on engineering for their solution.

In the beginning we said that agricultural engineering was the branch of scientific knowledge most recently applied to agricultural problems. For this reason if for no other it is also the least developed in India. For the same reason, perhaps it can do more to raise the standard of living, to change the methods and the equipment of the farmer in a way to make his

life more productive, easier, happier. Whatever we may do about large machinery, there is a large and fruitful field for the agricultural engineer in India, a field which will yield not only material rewards but the satisfaction which comes from contributing to the well being of others. We need a large number of agricultural engineers in the near future who will work for the development of the country, for the raising of the standard of living of the villager, not only in the amount of goods he may have available to consume but in the comforts and conveniences, in the relief from drudgery and in the making available of leisure for religious and cultural pursuits, for which the villager has so little time now.

PAIRA CROP CULTIVATION IN BIHAR

By M. P. Singh, M.Sc.,

Assistant Economic Botanist, Bihar, Sabour.

Paira cultivation is the name given to the process of broad casting pulse and oil seeds in the standing paddy fields during the months of September and October when the water in the paddy fields is low. This cultivation is commonly adopted in South Bihar a tract of varied soil types south of river Ganges extending up to the foot hills of Chotanagpur plateau and varies from alluvial to heavy clay. In the alluvial tract of North Bihar lying north of the river Ganges this kind of cultivation is practiced in the marginal lands only. In the red laterite soil tract of Chotanagpur the *paira crop* cultivation is not very common save in the districts of Palamu and Singhbhum.

Rabi pulses, chiefly gram (*Cicer arietinum*) and khesari (*Lathyrus sativus*) are employed for the purpose, though sometimes even lentils (*Lens esculenta*) and field peas are sown as *paira*. It is not uncommon to mix with gram and khesari either linseed (*Linium usitatiasimum*) or mustards (*Brassica sp*) or both. In Singhbhum district even in the lands situated near hills where plenty of moisture, due to the seepage from the hill side is available, the *paira* cultivation is resorted to.

Either overnight soaked seeds of gram and khesari or ordinary seeds are broadcasted in standing paddy plots at the rate of one maund an acre. In case the water in the fields is too much, draining is done to allow the germinated seeds to strike roots properly otherwise, as is the experience with the cultivators also, rotting of the seedlings takes place. Nothing is done to the *paira* sown crops till the harvest of paddy when they are allowed to grow and are harvested when ready. The seed yields obtained are very varied and are reckoned to be about half the seed yields of gram and khesari sown in the regular way. The seed yields in gram and khesari were observed to vary from 2 to 6 maunds and 2 to 8 maunds respectively at Siris, Nawadah and Bikramganj farms in Gaya and Shahabad Districts.

TABLE I.

*Yield per acre of gram and khesari sown paira.**

Farms		Gram									Khesari				
		Siris			Nawadah			Bikram-ganj			Siris			Nawadah		
Year.															
1931-32	..	..			..			..			11	30	12	..		
1932-33	..	..			..			..			11	8	8	..		
1933-34	..	3	23	0	..			..			5	10	0	..		
1934-35	..	4	4	0	..			..			8	4	0	..		
1935-36	..	2	31	0	..			..			3	17	0	..		
1936-37	..	7	12	0	..			..			15	0	0	..		
1937-38	..	4	0	0	1	37	0	..			3	35	0	..		
1938-39	..	4	13	0	2	26	0	..			..			3	8	0
1939-40	..	2	8	0	..			5	30	5	7	2	0	3	15	0
1940-41	..	3	10	6	..			4	33	6	..			2	33	0
1941-42	..	1	39	3	..			5	3	14	..			1	28	0
1942-43	..	8	32	5	..			4	12	10	..			1	11	0
1943-44	..	3	22	7	2	32	0	11	12	11	..			..		
Total	..	45	35	5	7	15	0	31	12	14	65	27	4	12	15	0
Average	..	4	6	14	2	18	5	6	10	9	8	8	7	2	19	0

*In maunds, seers and chattaks.

The seed yields obtained in case of linseed and mustards are very low indeed. No definite seed rate for these crops appears to be observed. They seem to be just mixed to act as a standby for the requirement for these oil seeds by the cultivator.

There appear to be several reasons why *paira cultivation* is adopted by the cultivators. The most important of them are mentioned below :—

In paddy lands where water keeps standing even after the flowering of paddy harvest *paira* is sown. It is also sown after *Jaldi bhadai* paddy in marginal lands which get cleared off its water by October but are too wet to be sown in time in the regular way. Advantage is, therefore, taken of the moisture to take whatever possible *rabi* crop. Pulse crops are sown as they are hardier than other *rabi* crops and also renovate the soil after paddy.

The practice of leaving the paddy lands fallow is sometimes decided to give only a partial rest and in that event it is alternated with *paira cultivation* and complete fallow.

After paddy harvest is the busy time with the cultivators as they have to thresh and store the paddy and whatever lands cannot be managed generally go under *paira cultivation.*

During the cold season scarcity of green fodder for the cattle gets acute as by that time even the grass on the *ails* (Field-borders) is also consumed. To provide green fodder for the cattle with the minimum of expenditure *paira* khesari is sown in paddy fields which normally remain fallow. This also helps to renovate to an extent the paddy lands which usually receive a very meagre dose of manures otherwise.

In lands which get inundated during rains *paira* gram is generally sown when the water starts receding. This prevents the attack of *Agrotis Ypsilon* Rott. (Cutworm) a serious pest of gram in seedling stages which cannot live in the land which is too wet and by the time the land is dry enough to harbour the pest the plants have grown considerably to suffer an attack from this pest.

The belief that the seed yield of crops sown, *paira* is about half that of the regular sown crop is amply substantiated by the yield per acre figures in the case of gram sown both *paira* and in regular way in paddy lands before and after the harvest of paddy at Siris (Gaya) and Jamui (Monghyr) farms.

TABLE II.

Farms	Siris		Jamui	
	Paira crop	Regular crop	Paira crop	Regular crop
Year				
1933-34 ..	3 23 0	8 13 10	..	..
1934-35 ..	4 4 0	11 11 0	..	..
1935-36 ..	2 31 0	6 27 0	..	..
1936-37 ..	7 12 0	8 28 0	..	..
1937-38 ..	4 0 0	6 13 0	2 9 0	5 0 0
1938-39 ..	4 13 0	7 18 0	3 0 0	4 20 0
1939-40 ..	2 8 0	8 37 0	2 0 0	4 36 0
1940-41 ..	3 10 6	8 31 0	2 12 0	5 25 0
1941-42 ..	1 39 3	8 4 2	..	..
1942-43 ..	8 32 5	8 34 13	..	..
1943-44 ..	3 22 7	6 21 1	..	..
Total ..	45 35 5	89 38 10	9 21 0	20 1 0
Average ..	4 6 14	8 7 2	2 15 0	5 0 4

The variable seed yields in the case of *paira sown* crops is mainly due to the failure of the crops due to water logging and in years when the moisture conditions in paddy fields is favourable at the time *paira sowing* is done better seed yields become available.

Low and very much varied seed yields obtained in the case of *paira sown* crops is a problem requiring investigation. Is the low seed yield of the *paira sown* crops due to the system of cultivation adopted, or due to failure of crop on account of water logging, both these points require going into in detail. In the event of the former could any alternative be suggested in view of the conditions favouring *paira* cultivation. Will it be of evolving early strains both of winter and autumn paddies so that regular cultivation could be done in paddy plots after the harvest of paddy should it be necessary to adopt regular culti-

vation instead of *paira* cultivation, or the problem could be solved in some other way. In the event of the failure of the crops due to water logging resulting in low seed yield could not the problem be solved by exploring into the possibility of a strain of gram and khesari that could tolerate better the water logging conditions generally present at the time when *paira sowing* is done.

The data reported in the paper was kindly supplied by the Dy. Director of Agriculture Bhagalpur and Patna ranges which is gratefully acknowledged.

MAKING RICE MORE NUTRITIOUS

Britain Develops New Hulling Machinery.

By Paul West.

More than 50 per cent. of the world 's population live on rice, the staple diet of many Asian countries. Rice has a lower nutritional value than grain, but it cantains starch, minerals and—most important of all—Vitamin B, which years of research have proved to be indispensable in the prevention of the paralytic disease known as beri-beri, so widespread in Eastern countries. It is, therefore, essential that the valuable substances should be retained as far as possible during the milling of the rice grain for human consumption.

Rice-milling consists mainly of the hulling and whitening processes, the latter being known in some countries as pearling, polishing or scouring. Hulling removes the coarse, inedible husks which have no nutritional value and which if fed to cattle, can cause physical injury. After hulling, the rice is whitened, a process which imparts the brilliant pearliness to the rice grains.

The conventional mechanical methods of hulling and whitening, however, have the disadvantage that they tend to rob the rice of some of its mineral and Vitamin B content. These valuable constituents are contained in the germ and in a thin aleurone layer of the bran. Hulling normally causes the germ to break. Tests have shown that about 95 per cent. of the germ is lost in this way. In the subsequent whitening process, a large proportion of the aleurone layer is removed, so that the finished, highly-polished rice hardly contains any minerals or Vitamin B. What remains is only starch product.

Main Principle

It is obvious, therefore, that the invention of improved methods of hulling and whitening augurs well in the interests of the rice-eating peoples of the world. A British firm has succeeded in constructing milling machines which do not harm the mineral and Vitamin B content of the rice. One of these machines is the Wemanco Ideal Huller in which only a very small percentage of the germ breaks. This is due to the fact that the machine dose not depend upon the use of milling stones or abrasives, but uses a combination of rubber and metal. Moreover the husk is removed in a single operation.

The remaining treatment of the rice grain is replaced by gentler methods. The main principle involved is that the rice grain is transported to the shelling point on a continuous rubber band. The underside of the grain is embedded firmly into the rubber band so that it cannot slip about. On reaching the hulling point, the berries, containing the valuable constituents, are ejected from the husks. In this way, every ripe grain, irrespective of size or shape, may be hulled. The delicate tips of the grain do not get chipped; none of the nutritional *endo-sperm* is lost and even protruding germs remain intact. The machine is capable of hulling one ton of rice an hour.

Polishing Process

The second machine is the Wemanco Ideal Whitener, a polishing machine operating on an entirely new, scientific principle. The whitening is carried out by means of a specially grooved rotor, the movement of which causes the meal to be peeled off the rice grain. At the same time, the mass of rice is subjected to a friction-process by a rapid plusating movement. Throughout the entire treatment, the rice is safeguarded from any undue pressure, so that the percentage of breakage is very low.

The finished rice leaves the machine with an attractive white pearliness. By means of a special regulating device, the degree of polish may be varied according to requirements. Should a few rice grains remain unpeeled in the machine, the husk residue may be disposed of by the action of the rotor. The machine which has a very low current consumption, is enclosed in a dust-proof metal casing and it is capable of dealing with 1,000 to 1,500 lbs. of rice an hour.

These British-made Wemanco machines are the result of 50 years' research in the field of mechanical rice milling. Many rice-consuming countries have shown a lively interest in these new developments because they realise the importance of such inventions in raising the standard of diet and health among the rice-eating peoples of the world.

—*British Information Services.*

STANDARDS OF SAFETY FOR BORE-HOLE LATRINES

[*Reprinted from Indian Journal of Medical Research vol. 33, No. 1, 1945.*]

Especially in as thickly populated a country as India, the sanitary disposal of sewage is a matter of some importance. It largely affects the incidence of intestinal parasities and diseases, which are a large part of the illness in India.

The borehole latrine has proven to be the cheapest and most easily installed and managed method of sewage disposal for individual family residences in the deep alluvial soil arears. There has been, however, widespread fear that its general use would result in dangerous pollution of the soil water. Up to now, it has been largely recommended only where it could be made in soil above the ground water level. Little experimental evidence has been available as to whether and how much actual pollution there was.

The following material is quoted by permission from the report in the "Indian Journal of Medical Research. Volums 33, No. 1, May 1945 by Dyer and Bhaskaran. It would seem to set at rest fear of pollution under the conditions specified which are much more likely to produce pollution than those obtaining where the borehole is kept entirely above the ground water level. This seems to be valuable contribution to knowledge on an important subject.

Discussion.

The present inquiry has revealed a naturally high standard of purity of the ground water at the site of the experiment in spite of the shallow depths at which it was tapped. Lactose fermenters were few from 3 to 8 oragnisms per 1,000 c c.of water and were for the most part of non-faecal origin. B. coli were virtually absent. The bacteriological purity of the water was little affected by seasonal and other environmental factors although the number of gas-formers decreased somewhat during the period.

Chemical analyses showed a low organic-matter content of the water in its natural state. This was indicated by the amount of albuminoid ammonia present. pH did not vary and the water was well buffered by bicarbonates. Minerals were present in only small amounts and were largely accounted for by carbonates and chlorides. Nitrities and nitrates were within limits.

Chemical constituents were affected by seasonal and environmental factors and the presence of pollution had to be interpreted in the light of these variations in the natural state of the water. Differences associated with depth were highly significant and those due to zone and period were also marked. There was even a well-to-well variation in the same zone and depth. Although seasonal trends were marked there were no conspicuous differences between those of the different zones.

The high bacterial purity of the water continued over two years, in wells above the latrine, although the water table rose to as high as 3 feet below the ground surface.

These observations indicate that shallow wells may not be dangerous from the hygienic point of view in this type of soil. Shallow wells, properly protected from surface pollution, may constitute the solution of the water-supply problem in rural India. The high cost of deep wells makes their use prohibitive and, furthermore, shallow wells have a lower mineral content than is found in the deep wells of the plains of India.

The other important finding in this investigation was the limited extent of the pollution stream entering the ground water from a bore-hole latrine. In a soil medium of sand as coarse as 0·2 mm. effective size and 40 per cent. pore space and with a ground-water slope of 1 in 200, bacterial pollution did not travel more than 10 feet from the latrine.

In judging pollution, the state of the ground water before the latrine was seeded together with the seasonal changes revealed by samples from wells against the direction of flow were used as a basis for comparison with changes occurring in wells lying within the stream of pollution flowing from the latrine.

When water is withdrawn from a well, surrounding soil water flows in to re-establish equilibrium. The distance affected depends on the amount of water withdrawn, the rate of withdrawal and the character of the soil, and this area is known as the circle of influence. By field experiment its radius was found to be about 20 feet at the site and the Du pumps were placed so that the latrine was within this range. By pumping 600 gallons each morning before sampling, a flow of soil water similar to that induced by the use of a rural village well was effected.

Gross *B. coli* pollution existed to a distance of 5 feet from the latrine and only one out of 13 wells in the stream flow showed mild *B. coli* pollution in the 10-foot zone. The flow of

B. coli occurred after septic action was set up in the latrine and was intensive over a period of two months (July-August, 1942). Later this organism was recovered less frequently and eventually disappeared showing its limited dispersion in the soil. Shallow wells were more intensely polluted than the medium or deep wells in spite of the high concentration of *B. coli* at the bottom of the latrine.

Organic matter indicated by the rise in biochemical oxygen demand also flowed a distance of 5 feet in a manner similar to bacteriological pollution except that it was recovered in more wells. Lactose fermenters plus a rise in B. O. D. were always accompanied by intense chemical pollution.

Chemical products flowed farther than bacterial and colloidal organic matter and were traced to 15 feet before becoming too dilute to be distinguishable. Unlike bacteria, chemical products flowed as a continuous belt along the stream with high intensity in the mid-stream wells. Shallow wells also showed more chemical pollution than either medium or deep wells. Apparently the flow of pollution is confined to the more fluid regions of the latrine and there is little flow downward into the deeper strata.

The picture revealed by the pollution recovery in wells is similar to that furnished by the flow of water through a sand-filter bed. In addition it gives insight into the processes in situ under the surface of the ground. Due to the ground-water slope, products from the more fluid regions of the latrine are carried along the stream and are filtered as they pass through the soil. The extent of flow of bacteria depends on the efficiency of the filtration process. The amount of chemical products that emerge is small and eventually becomes too dilute to be distinguishable.

Study of the changes in the bore-hole latrine showed that only a fraction of the added excreta was disintegrated and that the septic process proceeded only to the ammonia stage. The life of a bore-hole latrine may be extended by removing the sludge as is done with a septic tank. In this case there may be an increase in the flow of bacteria for a time, but the same defence principle will operate and pollution will travel little if any farther than it did in the first instance. The situation will be similar if a new latrine is driven in the neighbourhood of the original one since the defence mechanism has already been established.

Suggestions for Choosing a Site for a Bore-hole Latrine in Proximity to a Well.

The flow of ground water will follow roughly the slope of the land especially if the dip is toward a stream bed. The following suggestions are offered regarding the choice of a site for a bore-hole latrine :—

1. If space permits, the latrine should be placed on the slope below the well.

2. If the latrine must be placed above the well, a hole should be put down to ascertain the type of soil at a depth equal to that of the proposed latrine.

3. If soil at that depth is composed of sand with an effective size of 0·2 mm. or less, the latrine may be placed as close as 20 feet to the well.

4. If the sand is as coarse as 0·3 mm. effective size, the latrine should be placed 50 feet away.

5. If sand coarser than 0·3 mm. effective size is found, a careful study should be made before the latrine is placed.

6. If the soil is composed of clay, a distance of 20 feet is sufficient.

The only equipment necessary for obtaining soil samples is a post-hole auger and three standard sieves with meshes from 0·179 mm. to 0·35 mm.

Summary.

An investigation of the nature and extent of pollution flowing from a bore-hole latrine into the ground water was made at a site in West Bengal, India, during the period from September 1940 through April 1943. Preliminary studies were made of soil conditions, and the direction of ground-water flow and velocity were determined before the experimental field was completed and routine sampling of wells begun. The results of the investigation may be summarized as follows :—

A. Natural status of the ground water prior to seeding of the latrine :—

1. Bacteriological studies showed a concentration of lactose fermenters of from 3 to 8 per 1,000 c.c. of water, almost wholly of non-faecal origin.

2. Chemical analyses were made for pH, conductivity, chlorides, acidity, different forms of ammonia and B. O. D. Chemical constituents of the water varied significantly at different depths, zones and seasons.

3. Water samples from wells above the latrine and from those not in the immediate direction of flow were examined at intervals throughout the period and the results used as an indication of the normal state of the ground water.

B. Pollution flow following seeding of the latrine :—

1. The latrine was seeded with two gallons of night-soil on 330 days between November 1941 and April 1943. Septic action began in March 1942, and continued thereafter with undiminished vigour. The septic processes only reached the ammonia stage. Only a fraction of the excreta added was disintegrated and at the close of the experiment there was a 2-foot column of slugde in the latrine.

2. Routine observations were made of meteorological and ground-water conditions. Annual rainfall ranged from 40 to 80 inches, and the maximum slope of the water-table was 1 in 200. Effect of seasonal changes on biological decomposition in the ground water was not pronounced.

3. Experiments on the true and false water-table near the latrine showed that the differences were not large enough to affect the flow of pollution.

4. Six hundred gallons of water were pumped daily from wells situated 20 feet from the latrin in the direction of flow to simulate condtions of use of a village well.

5. Bacteriological pollution was recovered in wells 10 feet from the latrine with large numbers of B. coli found in wells in the 5-foot zone over a period of two months. Numbers diminished later and the organism was virtually absent during the final period.

6. Chemical pollution flowed with the stream to a distance of 15 feet. It was more intense in shallow than in medium or deep wells and was characterised by increase in conductivity, alkalinity, chlorides, acidity and ammonias. Nitrogenous products accounted for only a fraction of the pollution recovered.

7. Organic matter indicated by the 5-day test for B. O. D. was recovered in the 5-foot zone. It was probably colloidal in nature and was filtered out beyond that point.

8. Conductivity proved to be the most sensitive and hence the most satisfactory test for tracing chemical pollution.

9. Chrysomia larvae and their capsules were recovered from wells in the 5-and 10-foot zones where screens were damaged. They were found not only in wells in the direction of flow but all around the latrine.

[Copied from 'Investigations of Ground-Water Pollution Part III. 'Ground-water Pollution in West Bengal, India by Brian R. Dyer (International Health Division of the Rockefeller Foundation), T. R. Bhaskaran, D. Sc., A. I. C., A. I. I. Sc., and Statistical Treatment by C. Chandra Sekar, M. Sc., Ph. D. (Lond.). From The Indian Journal of Medical Research Vol. XXXIII. No. 1, May 1945, pp. 23—62. Thackar, Spink and Company, (1933), Ltd., Calcutta.]

SIMPLE TOOLS AND EQUIPMENT FOR SMALL SCALE FARMING*

By Mason Vaugh,

Agricultural Engineer, Allahabad Agricultural Institute.

When the modern agricultural revolution began, more or less along with the industrial revolution, much of the attention of the early pioneers in agricultural development was centered on the development of new equipment and on the development of techniques involving the use of equipment. Early agricultural workers seem to have recognized that agricultural practices were related to and dependent on the equipment with which the farmer works. As an instance, Jethro Tull's "Hoe Husbandry" dealt with the changes in agricultural practice that new implements made possible.

As the ancient sciences of biology and chemistry developed, attention was centered on their contributions to agricultural development. They were fascinating in themselves and they promised so much in changing the nature of plants, animals and soils. They had the further attraction that they seemed to be self contained; the botanist could experiment with plants in a green house, dissect them in a laboratory and grow them by hand without any real contact with the problems of the farmer. The zoologist and animal breeder could similarly work as a "scientist" with the minimum of contact with the day-to-day problems of the actual farmer. The chemist could and often did spend his whole life in pursuing fascinating and often important problems among his test tubes, flasks and balances. The application of their findings could be written in books and dealt with as abstract knowledge, some of which filtered into, and became important in, farming practice.

The developing industrial revolution made available material and manufacturing techniques for improved implements. It also made available, first in the steam engine and later in the internal combustion engine and in electricity, power sources which could put into the control of a single man undreamed-of forces. A man could exert more or less continuously about 0·1 hp. With horses he could control several horsepower but with the internal combustion engine he could easily control and apply 10, 25, 50, 100 hp. and thereby multiply his productiveness accordingly. The thinly settled countries of the

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Western Hemisphere gave full scope to this development and the relatively uncrowded countries of Western Europe also offered considerable opportunity. The rapidly increasing industrial development absorbed the increase in population so that each farmer had enough land to make it possible for him to apply the new equipment and the techniques they made possible.

Engineers and economists early pointed out that a man's productivity depended on the tools with which he worked and on the amount of power he controlled. In agriculture, productivity depended on whether a man worked with his bare hands, with a pointed stick, a simple hoe, a simple wooden plow, a modern horsedrawn gang plow or with tractor implements. It depended on whether he used his own muscles, a slow moving ox, a team of several intelligent and fast moving horses or a powerful tractor. In an agricultural situation where there was plenty of land for big farms and where industrial opportunity could absorb surplus population or even drain off some from the agricultural producers, it was natural for large scale equipment to be developed and to come into wide, if not universal, use. In this situation, while still important, development of better plant and animal material and of those processes and materials stemming from chemistry were not the most potent ways of increasing the net productivity, the net earnings of a man. Increasing the amount of power controlled and so the area covered through the utilization of efficient implements increased the productivity of the man more than an improved variety of plant or animal. Being able not only to control—to cultivate—a large area but to get a large area, the individual could command resources with which to buy the new, efficient implements and power sources which industry made available to him in variety.

"Modern" agricultural development took place first in the West. It started in a predominantly agricultural culture and developed in a period when there was a strong movement from farm families into technical and industrial pursuits. Cities were small and all classes of the population were closely related to the land. Therefore it was the common thing for the scientist, the plant breeder, the animal breeder, the chemist in the colleges and schools to have been born and to have lived on a farm and to have actively participated in farm life with his own hands, to have had actual farm experience not as a visitor but by actual participation in the day-to-day activities of a arm as a member of the family. Even yet, when the population

has largely shifted from a rural to an urban culture, it is the common thing for agricultural scientists in Western countries to have been farm boys.

When modern agricultural development began in Eastern countries, it developed in an entirely different setting. Most Eastern countries were already thickly populated. There was little spare land. Farms were small and often scattered in several small bits through the village area. Families lived in villages, not on the land directly. Labour was cheap and plentiful. The population was stable, comparatively few moving from the villages to the cities and industrial development was comparatively small, mostly concerned with such things as textiles, soap, consumer goods generally. The village was largely self-sufficient, made its own simple tools and implements, required little from outside.

Agricultural scientists too had a different background. Often or usually they were brilliant men but were from the "upper classes", the intelligentsia, from families where, even if they were connected with agriculture, the actual work was done by "servants". Rarely had they actually done field work because of the necessity of earning. They learned agriculture by studying in schools and colleges. It was easier to demonstrate practically and effectively chemistry, botany, zoology and to give "practical work" in them. It is small wonder, therefore that plant breeding, animal breeding, entomology, have been more attractive and that brilliant work have been done in them. Improved wheats have increased productiveness 20 to 25 per cent, coimbatore canes have increased sugar production in India as much as 100 per cent. It is not surprising therefore that relatively little work of an exact nature has been done and that relatively little has been accomplished in replacing the indigenous implements with improved implements in the thickly settled countries of the East. It is not surprising that when in recent time attention has been drawn to the need for improving agricultural production, attention should be centered on big implements and large scale methods.

What to introduce, what to consider an "improved' implement has been and is still a problem. To be successful, an improved implement must not only suit the soil and the crops grown but it must suit the draft animals available and the habits of work of the people, the climatic conditions and the repair facilities. An example of the need to fit into the habits of the people is illustrated by the reaction to the cast iron plow share in India. There the farmer does not pay for

each individual service of the village carpenter-blacksmith; rather he pays an annual retainer fee for which service is rendered as needed. Where most tools are hand made and metal is scarce, any scrap of steel, such as a wornout plow share, can be shaped into some other useful tool or bit of hardware such as nails. The cast iron share, when worn out, is an irritation because it cannot be made into anything useful by the village smith. This alone, aside from any other superiority of the steel share, may cause the village farmer to prefer a steel share.

Basic Implements in Use.

Little information is in print about the basic common tools and implements in use in the countries where the ancient patterns are still commonly used. One study was made in China by Ogden King of Nanking University in 1935. This listed a total of forty-three items, not all tools or implements, in common use in the region studied. A recent study made at Allahabad by a group working under the author, found some eleven items of small tools and implements in common use in the Ganges plain. They were the wooden plow, a clod crusher consisting of a single squared timber about 6″×8″ by about 8′ long, two types of small hand digging tools, a reaping hook, two types of hoes, one a heavy digging type and one a small pointed type for interculture, a cleaver-like chopper used for cutting fodder for the cattle, two crude simple types of fork and a wooden spoon for throwing water from irrigation channels. Items not covered by the study but in common use are the leather bag used for drawing irrigation water from the wells, clay pots and iron buckets used for the same purpose on a wooden sweep, carts for hauling crops, etc.

In the area stuided in the Ganges plain, very few imporved implements were found. About 22·5 per cent. of the total number of plows counted on 147 farms were improved plows, or sixty-one out of a total of 272. On the 147 farms twelve chaff cutters were found. No cultivators or winnowers were found though considerable numbers of cultivators, and a few winnowers have been sold in the province as a whole. Not enumerated were the iron persian wheel water lift used for irrigation and the iron roller sugarcane crusher. The latter is the best example in India of a successful improved implement. It was first introduced into India about 1890. By 1920 it had practically completely displaced the old stone mortar and wooden pestle type previously used. No other improved implement or tool has had anything like this success in India. In some places power driven crushers are beginning to replace the bullock driven types.

In other areas there are variations in the type of indigenous implement in use and the number of kinds varies from area to area but the general kind and function is not widely different. No studies of the kind other than these two have come to the attention of the author in India or in other countries.

Is It Desirable to Replace Indigenous Implements?

The author's personal experience is confined to India. However, on the basis of reading and discussion with those from other countries, it appears that there is practically no indigenous implement which cannot be replaced to advantage by an improved implement. There may be various criteria for judging whether an implement should be replaced or not. All of them should be considered before a decision is made one way or the other.

Too often in the past, the one criterion has been, "does it increase the yield ?" meaning does it increase the yield in the first season. Of course if the answer is in the affirmative, that is good. However some other advantages may be gained which would justify introduction even though no immediate increase in yield is evident.

The following are among the advantages that may be useful :—

1. A reduction in total human labour required to grow a crop. In oriental countries it is common for the man, his wife and the children more than a few years old to work in the fields. An improved implement, with the cultural practices it may make possible, may enable the man alone to carry the work most of the time, releasing the woman for better home making and the children for schooling.

2. It may enable certain types of work to be done at seasons when the indigenous implement will not work, thus spreading the work over a longer season and reducing the peak load at the busy season. Plowing during the previous dry season in preparation for sowing the monsoon crop in India is an example. There is a considerable period after the winter crops are sown and the monsoon crop is harvested when there is time to plow; unless there is unseasonable rain the soil is too hard for the wooden plow to work. Again, after the winter crop is harvested, in March, there is a longer period before the monsoon when improved implements will work but not the indigenous.

3. Closely related with the above is the possibility of greater timeliness of operation. Plowing in the previous dry season for instance makes possible early sowing after the beginning of the monsoon. This may or may not give some increase in yield in a normal season but it is practically always true that early sown crops do better when there is a partial failure of the monsoon.

4. The use of improved implements often makes possible certain cultural practices which in the end will increase yields, though the immediate effect may be small. Under Indian conditions, an instance of this is green manuring. When it has to be planted under the usual practices of preparing a seed bed in competition with the monsoon crop, there is very little chance of getting a green manuring crop planted in India. However if the soil is plowed roughly in the previous dry weather, an excellent stand of sann hemp, (Crotalaria juncea), can be had by simply scattering the seeds broadcast among the clods a few days before rain is expected. It needs no further attention until work would need to start anyway for the following winter crop, it keeps down weeds and adds useful nitrogen and organic matter to the soil. The wooden plow cannot handle the job of turning under the green manuring crop, the improved small steel plow can do so. The green manuring crop often adds materially to the succeeding crop and if done consistently will gradually build up the soil, though the annual increment may be small.

5. Improved implements may be important in the control of pernicious weeds. In India, large areas are practically out of cultivation and other areas are severely reduced in productivity because of *kans* (Saccharum spontaneum) and related grasses with underground stems. Bermuda grass (Cynodon dactylon) is a less serious but still important pest. The proper use of the correct improved implement will control and gradually eradicate these; the indigenous implement can keep the bermuda grass under some control but, once started, the kans will take a field from the indigenous plow. Again the process may have to be gradual, spread over several years before final eradication.

What Implements and Tools Should be Introduced?

Again based on Indian experience, it seems clear that no one implement can fully replace the wooden plow, though it is the first implement which should be replaced where it is

in use. The substitution of the combination of a small steel soil inverting plow and a simple type of cultivator or horse hoe, with attachments to each of them, will meet practically all the needs of the small farmer for field culture.

The plow should be of steel rather than cast iron, because it should meet conditions were a sufficiently strong cast iron plow would be undesirably heavy; because the steel plow can be sharpened repeatedly with the tools of the village blacksmith or even with tools not out of the reach of the farmer; because the parts when worn beyond use on the plow still have a use in the village.

The size of the plow should be between 6" and 8" bottom. Less than 6" is ineffective as a turning plow, more than 8" wide is likely to be outside the power capacity of the work animals under severe conditions. The narrower bottom works better under severe dry conditions, the wider does a better job of turning under green manure crops. There would be some advantage in having two interchangeable bottoms, one especially for dry conditions, the other for turning under green manure and weeds.

The quality of materiel is not critical. "Plow steel" or steel of ·60 per cent. to ·75 per cent. carbon is suitable but for the areas where scouring is not a critical problem, ordinary commercial mild steel can be used for all parts except the share. Solid steel is preferable to soft centre steel because of cheapness and because it is easier for the relatively unskilled smith to handle. In any case, the share should be of solid steel, about ·75 per cent. carbon and it need not be heat treated. The farmer should be able to sharpen it by could peening with a hammer, taking it to the blacksmith only when the edge gets thick.

While it is more costly, the small steel beam plow with a curved I section beam, to be hitched with a chain, is decidedly perferable to the type having a wooden pole beam. It handles better in the field, can be fitted with one or two handles, can be used with one or two animals. Small plows with short wooden beams are also practicable.

Desirable attachments are furrow makers and sweeps which are interchangeable with the mould board bottom. These may be of steel and of various sizes. The furrow makers are useful for making furrows and ridges for various crops, for irrigation

channels, etc. The sweeps are useful for eradication of weeds and for certain types of interculture.

The cultivator which seems most desirable is a small five tined implement generally similar to the American "horse hoe." We have found a pattern with somewhat more clearance desirable and have left off the small wheel. Elimination of the wheel makes possible the use of the cultivator for "straddle row" operation on small plants, which is preferable when the plants are small, the row spacing is narrow and irregular. Removal of two standards reduces it to three tines and adapts it to severe conditions or small animals. By fitting wider shovels, 3 1/2" to 4", on the three back tines and by fitting a funnel and spouts leading to them, the cultivator can be used for seeding. In operation, the cultivator is handled and the animals controlled by a man while the seed is dropped into the funnel by another person, usually a woman. Three spouts can be used for closely spaced crops such as cereals, two may be used for such crops as maize, sorghum, etc., to be planted in wider spaced lines. This secures most of the advantages of the seed drill, except automatic control of the seed rate. In practice, it has been found that work people get remarkably even spacing of the crop this way and that the seed rate can be satisfactorily controlled. The investment is far less than that required for a seed drill and the work is better when sowing under a deep mulch as is practiced in some areas having deficient or irregularly spaced raintall. The attachment can be made locally of local material, iron pipe or bamboo being used for the spouts and wood or tin for the funnel.

With these two implements and the attachments suggested, the farmer can do most field operations. The wooden clod crusher or planker may be retained. A light hand hoe with a handle long enough to enable the user to stand is useful.

The above does not provide for any improvement in the harvesting and threshing equipment. For the small farmer having only a few acres, little can be done at present to improve the harvest. The scythe shatters too much grain; the cradle takes too much effort to work it; reapers and mowers now available either are not adapted to the work required or involve too large an investment or both. The binder, in addition to other disadvantages, requires considerable cost in twine.

Improvement in threshing is easier than in harvesting. Various kinds of sleds, rollers and frames fi ted with smooth or

toothed disks may be used with animals to considerably reduce the time required to thresh by trampling or with a flail. At least in some areas, small power operated threshers and winnowers, operated on a custom basis may well be introduced. The combine harvester, as a custom cperated machine has promise for the future but is not immediately applicable to very small farms with scattered fields. There is still need for much development work to meet this need. A simple fan to be hand driven to produce a blast of air is a useful thing when winnowing by hand is carried out.

The Economics of Better Implements.

It is not always easy to assess the economic benefits of improved implements. Some of the benefits, as previously pointed out, are social rather than economic. In many cases, the benefit possible from the implements is only fully realized if and when *improved practices* made possible by the improved implements are brought into use. In many cases, where farms are large enough to require two units of an implement, the capacity of the improved implement is such that one is enough. Where this is possible, the saving in the cost of one pair of animals is more than the cost of the new implements. In other cases, the increased yield will pay for the implement in one or two seasons. In other cases, reduction in the time required may enable the farmer to work for others enough to earn the cost of the implements. In general, it can be said that the increased yields resulting from the use of the proper improved implements will quickly pay for the implements, assuming that the implements are suitable and not out of relation to the work to be done. In many cases the improvement in yield due to the improved practices possible when better implements come into use may be as much as 100 per cent. of the original yield. When other social and human values, such as the release from drudgery of the women and children, are taken into consideration, the improvement becomes doubly desirable.

Can Farmers Afford Imporved Implements?

The ability of farmers to afford improved implements is often questioned and the plea of poverty is often used to evade such purchases. How far is this plea justified? It is true that many small scale farmers are poor. It is also true that in general they cannot afford to experiment. They need to know before purchasing that the implement will be useful. Perhaps some

farmers in every area will really not be able to afford improved implements. In most cases they can secure the necessary money either from current funds or by savings on amounts spent for wedding and other feasts and festivals of sorts. In many cases they borrow for non-productive purposes. Few if any will be unable to raise the price of an improved plow either by savings or by curtailment of unessential expenditure for social purposes, or by borrowing.

Where it may not be possible to buy a full set of improved implements at one time, often one or more things can be bought in a year and the purchase can be spread over several years. Often savings or profits from one purchase can be applied to further purchases.

What Are the Obstacles to Introduction of Improved Impelments?

In general, the greatest obstacle to bringing improved implements into use is ignorance. The farmers do not know what implements are available or what benefits may be expected from their use. No real sales effort has been put into showing them.

In some cases, wrong types, unsuitable materials used in the manufacture, poor construction have discouraged early purchasers and through them others. In many cases, unjustified claims by ignorant advocates have led to disappointment and prejudice against improved implements. In many cases, introduction of only one improved implement where two or more were needed to fully replace an old implement has left the old one in use and habit leads to gradual reversion to use of the old rather than to progress toward complete use of the new. It is desirable to introduce implements in such a way that the old implement displaced is completely rendered unnecessary. If in a particular case improved implements are not immediately available, intensive efforts should be made to complete the provision of improved types to make complete substitution possible.

Summary.

The agricultural revolution which has occurred in the last two centuries started largely with the improvement in implements. Changes in the process of development centred attention on biology, chemistry and plant and animal breeding. The

industrial revolution put large scale power and the implements with which to apply it into the hands of western agriculturists and the development of animal drawn or small scale implements became unnecessary in the West.

The kind of implement to introduce must be decided not only on economic conditions but the habits of work and thought of the people, the climate and repair facilities. The basic implements in use are simple and few. Improved implements are available which will do everything an indigenous implement will, will often do them better and generally will do more work in a given time and with given power.

The two basic implements to introduce in most cases will be a small soil inverting plow and a small cultivator with suitable attachments for both. Steel is preferred to cast iron. The size of implement should generally be small, in keeping with the size of animal and of holding.

Little at present can be recommended in the way of improvement in harvesting equipment and only slightly more for thresing. For the most part, improved equipment for these will have to be provided by other means than individual ownership.

Generally speaking, the introduction of improved implement will be profitable in money, besides social and human advantages, such as release from drudgery. Usually savings or improved earnings will pay for the implements very soon. Farmers can usually meet the cost without difficulty when convinced of the value of the implements.

FARMER-CONTROLLED ARTIFICAL INSEMINATION CENTER.

Australia's first farmer-controlled artifical insemination centre for the breeding of dairy cattle has been opened at Timboon, Victoria. It has 60 farmer members, more than 1,000 cows have been registered and two proven Jersy sires have been bought.

A non-profit-making concern, the Timboon and District Artifical Breeding Association has been financed entirely by its members; £A.2,200 was subscribed to meet the cost of first year's operations.

Membership fee is 30 shillings a year, and the charge for each cow registered for service is 25 shillings, covering three inseminations if necessary. The insemination charge for cows owned by non-members is £A5/5/- a cow.

The centre has, one permanent inseminator, Mr. D. Perrot, who trained under the Department of Agricultural Veterinary Department of the Victorian State Research Farm at Werribee. Mr. Perrot makes his daily round in the Association's car. Farmers notify him by telephone when their cows need service.

Semen is collected from the two bulls twice weekly and preserved in a refrigerator in the Association's temporary laboratory.

It is hoped to form sub-units of the Association which should cut over-head costs and probably enable the 25 shillings insemination fee to be halved within two or three years.

THE

ALLAHABAD FARMER

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EDITORIAL NOTES.

This issue of the Allahabad Farmer.

The September issue of the Allahabad Farmer has for several years been a special number in which are given the reports of the departments of the Allahabad Agricultural Institute. The reports have been prepared keeping in view the interests of our readers, who may be interested to know the technological developments which are taking place in the Agricultural Institute. As some of our readers are alumni of the Institute, we hope that the news about staff changes will be of particular interest to them.

List of Articles in the Allahabad Farmer.

Our readers may be interested to know what articles have been published in the previous issues of the Farmer. In order to enable the readers to find out more easily what articles have been published, we have arranged them subject-wise. The price of each back number till Vol. XX No. 6. 1946 has been fixed at As. -/4/- each and from Vol. XXI No. 1. 1947 onwards the price of each copy has been fixed at As. -/10/-. As the number of old copies is limited we cannot guarantee that the numbers asked for will always be supplied.

PRINCIPAL'S REPORT FOR THE YEAR JULY 1948 TO JULY 1949.

(H S. AZARIAH)

In the absence of Dr. Mosher once again I have been asked to prepare this report.

Our staff has been considerably strengthened by the return of Dr. C. O. Das and Dr. and Mrs. T. A. Koshy from their studies in the United States. In July of this year Mr. B. M. Pugh came back to us and Mr. and Mrs. Brewster Hayes returned from furlough. We were also happy to welcome Mr. and Mrs. Joseph Short who are being supported by the Friends Service Council, London. Mr. Short has joined the Department of Extension and would be devoting his time to horticultural extension. We were expecting Mr. A. P. Brooks but it is now known that he would not be back until July 1950.

While we are happy to have all these additions to the staff, we are experiencing acute shortage of housing facilities. The Hayes, for example, had to shift three times before a satisfactory arrangement could be made. This is partly due to the delay in construction and completion of the hostels as we had not been getting cement and steel. We had to drastically retrench our building crew as we could not proceed at the pace we wanted for lack of materials. Now that both cement and steel are available the work is going on and yet this shortage of staff quarters is likely to continue as we expect to strengthen the staff further.

In July 1948 we admitted a double section in B.Sc. Agriculture which brought the total number of students during the year 1948-49 to 303. The present total number of students is 321 including 17 women students taking Home Economics courses.—Students still continue to come from all parts of India and Ceylon. We are now expecting two students from Abyssinia who are coming to India on a good-will exchange. This is a good thing for the Institute as well as for India as it would help both the staff and students to get over the narrow provincialism and prejudices and think in terms of India as a whole. The examination results were on the whole very satisfactory. The number of successful students for 1948-49 being:

Inter. in Agriculture	59 passed out of 71
B Sc. in Agriculture	28 „ „ „ 34
B Sc. in Agr. Engineering	14 „ „ „ 18
Inter. in Home Economics (women) ..	13 „ „ „ 13

In order to help the students to get a broad education we introduced from July 1948 courses on Better Citizenship, one period twice a week. During these periods we had lectures from prominent persons and these were followed by a discussion period during which students were given opportunity to freely express their opinion and clear their doubts. The courses in Religious Education were also better organized. This experiment had proved so successful that we are continuing it again this year.

With the Independence of India rapid changes are taking place in every field and new methods and experiments are introduced without giving full consideration to the consequences. The railways for example abolished the four-class system of travel and introduced three classes. Within a year of their enforcing this system it is thought probable that four classes would be reintroduced with different names! Similarly in the field of education English was eliminated in certain lower classes in Madras; and after an year of experimentation they have re-introduced English in a modified scale. The Intermediate Board of Education, U. P. has also changed the syllabus of Intermediate students rapidly. As one examines these rapid changes in India, one often wonders what would happen to the general education system in India and to the place the Agricultural Institute could take in that general system. Some people are very much disturbed about the changes. But one thing seems to be certain that as long as the Institute does a good job in agricultural education, research and extension, both the government as well as private individuals would continue to look to the Institute for help. I believe more opportunities for wider services, are yet to come. Therefore, we still believe that in spite of the rising clouds of doubt, God would use this work to the advancement of His Kingdom in this great land.

REPORT OF AGRICULTURAL ENGINEERING DEPARTMENT, 1948-49

By

MASON VAUGH, A. E.

The year has on the whole, been one of progress and development, in the Agricultural Engineering Department. Though we are far from perfection yet, still we feel that we are in a better position than for several years to do our job.

There were several changes in the staff. Mr. Pahalwan left to join the Agricultural Engineering Department of the U. P. Government, in the middle of the year. Mr. E. J. W. Moraes was transferred from Research to teaching for the remainder of the year but left to take another job at the end of the year. Mr. Watford left to go to a Mission School at the end of the year. Mr. S. E. Roy and Mr. J. J. Fenn of the class of 1949 joined the teaching staff and Mr. E. C. Peter joined the research staff also of the class of 1949. Mr. Nand Kishore Mathur, M. Sc. with 10 years teaching experience has joined the staff to teach physics and mathematics. During the year, Mr. Vincent's office was brought up from the basement and the entire engineering offices are now in one block.

Several pieces of new equipment have been received during the year, a power driven sprayer, and a tensile and compressive testing machine of 10,000 lbs capacity being among the larger items. Unfortunately, an impact tester for the materials testing laboratory was lost on the railway enroute from Calcutta and we have not been able either to get the machine or compensation for it. Until compensation is received, we cannot order a replacement.

A notable development which originated during the year and was finalised just at the end of the year is the establishment at the Institute of a Government Testing Station for the testing and evaluation of all sorts of Bullock drawn and hand operated implements and tools. It will not be concerned with tractors or tractor implements but will deal with the whole range of hand and bullock power items. The station is to be under the Chief Agricultural-Engineer of the Agricutural Engineering Department who is meeting the expenses of the station in his budget. Local supervision will be under the head of the Agricultural Engineering Department of the Institute. A graduate Agricultural Engineer is being stationed here to be responsible for day to day operation of the station, testing procedure, etc. As the report is being

written, some of the test apparatus which it has been necessary to construct locally is nearing completion. It is hoped that before this report is off the press the station will be functioning. It can be of great service to the public and to government agencies in giving them a basis for judging the quality of implements offered to the public.

Note should be made of the return from Foreign Study of three of the first batch of Agricultural Engineers graduated from the Institute. All three had distinguished careers as students in their respective Universities and their record will make it easy to get admission for others. All three have been immediately absorbed. Majid Hasan Khan has been appointed Agricultural Engineer to Government, West Punjab. Mihir K. Nandi is Agricultural Engineer to Government (Research) U. P. and S. C. Bhatnagar is on special duty with the planning commission of the Province but it is expected that he will be permanently posted in the Agricultural Engineering Department.

Implements manufacture and development has progressed at about the same pace as for several years. During the year the Workshop of the Institute has been registered as a factory and so becomes eligible for allotment of steel for fabrication, though no allotment has as yet been received. The new 75 ton punch press has been installed and brought into operation. This will greatly faciltate the implements manufacture program.

Further development work was done on the Shabash cultivator particularly with a view to fitting to it a 4 row seeding attachment. A 3-row attachment has been in use for the last two years but there are reasons for trying to make it a 4 row instead. The Wah Wah set has been redesigned with an entirely new cultivator attachment and the seeding attachment is under development to allow it to sow 4 rows in place of the previous single row.

The new winnowing fan, described in the May 1949 issue of the Allahabad Farmer has been further developed and has been much appreciated by those who have seen it. The new design not only provides a good blast at a suitable height but the operator can get a cooling breeze from the back of the fan as well. It is easily operated with one hand. Cost has not yet been determined but it is expected to be within the reach of most farmers.

Building operations have been very much hampered during the year by lack of cement. The new cafeteria in

Hostel No. II was used without a pakka floor at Christmas 1948 for a student conference but it was 8 months later, just as this report is being prepared, that it was possible to complete the first half of it and bring it into use. It has largely remedied the previous complaint of slow service. Very little waiting in que is now necessary with two serving lines in operation. Some arrangements are still improvised and will have to remain so till further construction can be done. Due to lack of cement, construction of additional staff quarters was very much delayed, resulting in considerable inconvenience to staff at the beginning of the year. It is hoped that three suites can be finished during the coming year which will ease the situation somewhat.

Steps were taken during the year to make the engineering course a 3 year course instead of the present 2 year. The necessary changes in the syllabus have been drawn up and approved by the Institute staff. They were presented to the committee of courses in Agriculture and Agricultural Engineering of the University which approved them. It is likely that the additional remaining steps may be taken so that students entering in 1950 may enter for the new course. This has long been desired by students to bring the course more into line with other engineering courses instead of with arts and science courses.

Graduates of the course are proving its value. Most of the graduates have been employed immediately after graduation and have on the whole done very well. Increasingly the B. Sc. Agricultural Engineering is being specified as a qualification for posts and most of the graduates of the course have done exceedingly well, considering the breadth of the field and the shortness of the course and of the time it has been established. Again at the admissions in July 1949, several times as many applied for admission as could be accomodated.

This report would hardly be complete without reference to the flood of 1948. In the absence of any prediction as to the height the flood would reach, attempt was made to keep it out of our basements. This was unsuccessful but the engineering department was fortunate in that it was able to get practically all its valuable machinery, electrical equipment, etc., above water level before the maximum stage was reached. Fortunately the electrical service was maintained, even though it was necessary to work without metering the supply for about 10 days. During most of the time some water service was maintained and we learned a lot about how to

meet such an emergency in the future. We hope the information can remain interesting but useless. This reference to the flood would also be incomplete without a reference to the splendid way that members of the staff and workmen of the department stayed on the job to maintain such service as was possible even when their own homes were in danger and their families inconvenienced. Their hard work and loyalty enabled full services to be restored much earlier than would otherwise have been possible.

REPORT ON THE DEPARTMENT OF ANIMAL HUSBANDRY AND DAIRYING, 1948-1949

BY

JAMES N. WARNER, M.Sc.

PERSONNEL.

Dr. T. W. Millen ..	Professor of Animal Husbandry and Dairying ; Department Head ; (on leave, resigned in December 1948.
Mr. J. N. Warner ...	Professor of Dairying ; Officiating Department Head ; Milk and Milk Products.
Dr. A. W. McClurkin ..	Professor of Animal Husbandry ; Veterinary Science and Animal Nutrition.
Mr. I. N. Mathur ...	Lecturer in Animal Husbandry ; General Supervisor of Cattle Yard Operations ; Animal Genetics.
Mr. R. P. Arora ...	Assistant Lecturer in Animal Husbandry ; Animal Husbandry Accounts and Records.
Mr. D. Sundaresen ..	Assistant in Dairying.
Mr. S. E. Boaz ...	Assistant in Animal Husbandry.
Mr. M. J. John ...	Assistant in Animal Husbandry, May to February.
Mr. P. T. Basu ..	Assistant in Animal Husbandry, January to March.
Mr. O. B. Tandon ..	Assistant in Animal Husbandry, to June.
Mr. P. S. Indapurkar ...	Assistant in Animal Husbandry, to June.

Mr. L. P. Srivastava .. Research Assistant in Dairying, to February.

Mr. S. R. Biswas ... Dairy Manager.

Mr. D. E. Jacob ... Creamery Supervisor.

Word came from Dr. T. W. Millen in America early in December 1948 that he had resigned from the staff of the Institute. Mr. S. E. Boaz, Mr. M. J. John, Mr. S. R. Biswas and Mr. D. E. Jacob each joined his post in the department in May 1948. Mr. P. T. Basu joined his post in January 1949. At the time Mr. Biswas took up his work as Dairy Manager, Mr. D. Sundaresan was relieved of those duties so he could give full time to teaching work. Mr. P. S. Indapurkar left his work in the department in June 1948. Mr. O. B. Tandon left the department in June 1948 to proceed to the U. S. A. for advanced studies at Iowa State College in Animal Breeding. Mr. L. P. Srivastava left his work in the department in February to become Manager of the Co-operative Milk Supply Union, Ltd., Allahabad. Mr. John was transferred to the department of Extension of the Institute the middle of February 1949.

MILK AND MILK PRODUCTS.

For the first time in several years fluid milk sales diminished this year as compared to the year previously. These sales, however, are again no indication of the demand for milk from the Institute Dairy. That demand remains much higher than the Dairy is able to meet ; we continue handling in our Dairy only the milk produced in our own herd. Whereas in 1947-48 the Cattle Yard supplied the Dairy 4,70,160·2 lbs., only 3,63,390·0 lbs. were supplied during the current year.

Sales of fluid milk were 3,16,592·5 lbs., Table I, or 74,609·5 lbs. less than a year ago. The average daily sales this year were 867·4 lbs., which is 204·4 lbs. a day less than in 1947-48. Less *dahi*, ice cream and skim milk were also made and sold because of the smaller receipts of milk.

TABLE I

Sale of milk and milk products, 1948-49.

(Figures in pounds.)

Month	Bulk milk	Bottled milk	Butter	Skim milk	Dahi	Cream cheese	Cream	Ghee	I ce cream
April	28,047·5	1,350·0	1,198·2	1,497·0	743·5	..	20·2	19·0	1,4 8·0
May	24,295·5	1,142·0	837·5	1,111·0	1,057·0	..	37·5	23 5	1,802·0
June	21,469·5	826·0	799·4	489·5	994·0	..	16·6	..	826·8
July	24,700·5	703·0	696 5	214·5	516·5	..	2·8	..	623·9
August	24,566·5	360·0	675·8	43·0	401·5	..	4·3	1·8	154·2
September	21,286·0	237·0	353 5	137·0	127·5	..	4·9	0·3	111·2
October	24,296·5	135·0	747·0	63·5	340·0	..	6·0	..	109·0
November ..	25,618·5	123·0	821·1	642·5	202·5	2·8	7·6	0·2	24·5
December ..	27,873·5	122·0	987·1	947·5	172·0	..	19·9	..	--
January	31,696·0	152·0	768·2	604·5	231·5	19·3	28·6	..	..
February	27,798·5	168·0	703·1	310·0	279·5	2 5	29·2	13 8	137·0
March	29,442·0	184·0	816·2	519·0	824·0	13·9	28·8	20·0	708·8
Totals ..	3,11,090·5	5,502·0	9,403·6	6,579·0	5,889·5	38 5	206·4	78·6	5,965·4
Previous year totals ..	3,91,202·0		13,324·8	3 8,211·9	7,000·5	2·6	419·5	49·8	8,694·0

TABLE I—*contd.*

Sale of milk and milk products, 1948-49.

(Figures in pounds.)

Month	Cheddar cheese	Daily average of whole milk
April	33·3	934·9
May	124·9	783·7
June	131·5	715·6
July	86·8	796·8
August	45·8	792·4
September	237·3	709·5
October	94·3	783·7
November	95·8	853·9
December	17·0	899·1
January	13·2	1,022·4
February	4·0	992·8
March	72·7	949·7
Totals ...	956·6	867·4
Previous year totals ...	1,259·4	1,071·8

S.R.B.

Only 28,935·5 lbs. of milk were separated this year, as compared to 43,405 lbs. last year. The cream so obtained, together with that received from the Cattle Yard, from milk separated to provide skim milk for calf feeding, was used largely in making ice cream, although some was sold as fluid cream.

Of the cycle delivery units reported last year, considerable trouble was experienced with the side car unit; the load distribution on that unit was such that the spokes of the rear cycle wheel broke very frequently. The use of heavy duty spokes did not completely overcome this trouble, although it helped to some extent.

Two additional cycle delivery units were contructed this year. Both were built somewhat like the ordinary cycle riksha. Each has a carrier, rather than a seat for passangers, supported over two rear wheels which replace the one rear wheel of a bicycle. This carrier, measuring about 34″×30″ ×11″ is suspended by two leaf-type heavy-duty springs. Both these units are working satisfactorily.

As a means of preventing tampering with the milk by persons handling it between the dairy and the customer or his agent we continued the procedure, reported last year, of sealing the tightly shut lids of the delivery cans and then sealing the cans in position on the delivery cycles. Later in the year we constructed a new type of lid cover which extends completely over the can lid and down the outside of the neck of the can to the can shoulder. This lid is fixed into place and sealed to the can shoulder after which the can is sealed to the delivery cycle. This arrangement has proved an additional safeguard against the practice of tampering with the milk.

A new tamper-proof milk valve was designed during the year. A new valve will be constructed according to that design and studied before further report is possible.

The sales of milk and milk products at the milk bar during 1948-49 are shown in Table II.

TABLE II

Sale of milk and milk products at the milk bar, 1948-49.

(Figures in pound.)

Month	Bulk milk		Bottled milk	Butter	Dahi	Cream	Ice cream	Cheddar cheese	Chocolate milk (glasses)
	Wholesale	Retail							
April	...	4,854·0	902·0	289 8	484·5	...	216·5	3·5	...
May	...	4,426·0	753·5	247 4	598·5	1·0	238·5	4·9	...
June	...	5,849·0	584·0	234·9	550·0	6·4	134·5	0·5	...
July	...	3,654·5	515·0	135·8	290·0	1·2	80·5	2 0	...
August	...	2,971·0	133·0	121·5	196·0	...	59·9	0·9	...
September ...	...	2,813·5	42·0	44·7	65·0	...	12 8	9·0	...
October	...	3,257·0	...	119·4	204 5	...	12 5	7·5	15
November	...	2,988·0	...	161·4	118·0	...	...	12·0	...
December	...	2,977·5	...	139·7	90·5	...	1·8	...	644
January	4,494·5	3,099·5	...	115·2	123·0	...	...	...	191
February	4,291·0	2,999 5	...	95·1	124·0	2·0	20·0	...	...
March	3,202·0	3,538·5	...	140·5	360·5	8·4	93·8	9·5	...
Totals ...	11,987·5	41,428·0	2,929·5	1,845·4	3,204 5	19·0	870·8	49·8	850
Previous year totals ...	47,834·0		12,424·0	2,959·1	8,311·5	17·9	2,174·5	59·8	229·0

S. R. B.

MILK STOCK

The number of milk stock, Table III, diminished from 171 to 160. This is in line with our policy of maintaining about 160 head of milk stock. This policy is determined by several factors, one of the most important of which is the capacity of the Institute Farm to produce and supply the necessary fodder. For purposes of an intensive programme of breeding work, such as we have been carrying out for several years, this number is admittedly small; but it is not considered economical to purchase fodder in the open market in order to maintain a greater number of milk cows. We prefer making our herd as economical as possible, even if it necessitates taking a somewhat longer period of years to carry out the particular programme of breeding which we follow.

The average production of the different breeds or grades of animals in our herd, together with other data, is given in Table IV. Compared with a year ago, there were increases in the average lactation production of the Jersey-Sindhi and 1/8th Brown Swiss-Sindhi groups.

TABLE III

Milk stock statistics, 1948-49

Serial No.	Breed	Number on 1st April, 1948	Transferred from female young stock	Sold	Died	Number on 31st March, 1949
1	Red Sindhi ..	41	2	14	1	28
2	1/8 Jersey-Sindhi ..	12	7	5	..	14
3	1/4 Jersey-Sindhi ..	32	2	2	3	28
4	Jersey-Sindhi ..	15	..	1	..	13
5	3/4 Jersey-Sindhi ..	..	2	1	..	3
6	9/16 Jersey-Sindhi ..	1	1	..	..	2
7	5/8 Jersey-Sindhi ..	2	3	..	..	6
8	1/8 Brown Swiss-Sindhi	8	1	5	1	4
9	1/4 Brown Swiss-Sindhi	7	1	1	..	7
10	1/16 Holestin-Sindhi ..	..	2	1	1	2
11	Miscellaneous ..	33	4	5	3	27
12	Murrah (buffalo) ..	20	8	2	..	26
	Totals ..	171	33	37	9	160

R. P. A.

Both the length of the calving interval and the age at first calving this year further confirm our conviction that the concentrate feeds now available for milk stock and young stock are such that it is impossible to formulate a completely balanced ration for such animals. Since very early in the recent war wheat bran has been unobtainable. For several years bone meal was unobtainable as well. Since the war we have been able to obtain very small and irregular quantities of wheat bran. We have recently been able to purchase a fairly good quantity of bone meal. Both of these essential feed materials contain large quantities of valuable minerals mainly calcium and phosphorus. Because of these shortages, and clinical conditions appearing in our herd, we began

TABLE IV

Lactations completed during 1948-49

Serial number	Breed	Number of lactations completed	Average yield in pounds	Average days in milk	Average days dry preceding the lactation	Daily milking average	Daily overall average	Number of heifers
1	Red Sindhi ..	17	2,803·4	340 3	115·9	8 23	6·14	2
2	1/16 Jersey-Sindhi ..	3	2,995·4	319·5	166·5	9·37	6·16	1
3	1/8 Jersey-Sindhi ..	9	3,427·0	405·4	179·8	8 45	5·85	4
4	1/4 Jersey-Sindhi ..	23	3,478 6	346·1	81·4	10·05	8·13	6
5	Jersey-Sindhi ..	9	4,451·6	413·6	121·8	10·76	8·31	1
6	Jersey ..	1	2,485·7	348 0	62 0	7·14	6·06	..
7	1/8 Holstein-Sindhi ..	2	3,289 0	375·0	58·0	8·77	7·59	1
8	1/8 Brown Swiss-Sindhi	6	3,722·1	417·0	78·0	8 92	7·51	5
9	1/4 Brown Swiss-Sindhi	2	3,307·4	287·0	99·0	11·52	8·56	1
10	Miscellaneous-Sindhi .	3	4,916·1	406·0	65·0	12·10	10·43	2
11	Miscellaneous ..	11	4,562·3	447·7	82·0	10·16	8·75	7
12	Murrah (buffalo) ..	13	3,020 2	280 2	100·8	10 77	7·94	5
	Weighted average for the herd.	99	3,537·4	365 4	100·8	9·67	7·61	35

R. P. A.

in December, 1948 to supply *ad lib* a mineral mixture formulated to supply not only ordinary salt but the more important minerals commonly fed as well as several of the trace elements such as cobalt, manganese, magnesium, copper and iodine. The results obtained so far, as indicated by the condition of our animals, suggest that they may have been suffering from a trace element deficiency during recent years, in addition to deficiencies of calcium and phosphorus. This presumption has not been proved conclusively as yet. We will consider proof is available when we have reduced the calving interval in our herd to about 400 days or less and the age of our heifers at first calving to about 3 years or less.

FEMALE YOUNG STOCK

The number of female young stock is shown in Table V. Death losses were especially heavy in this group of animals this year because of a serions epidemic, involving almost exclusively the young stock, which occurred in the herd immediately after the floods of September. Those floods involved the highest water level in the Jamna River since 1875. All paddocks, silos and barns were flooded, making it necessary to move all our milk animals to a very small portion of the Institute road near the main gates. They were confined to this small area with no protection from sun or rain for nearly two weeks. All young stock were crowded into small pens normally used for calves from 2 to 6 months of age. Water stood at the maximum flood level for over a week. A portion of the paddocks and barns, however, were flooded for more than two full weeks. Much of the water, especially near the animals where it was rather shallow, became very stagnant during this time. It is probable that the infection was brought in with the flood water and then incubated as the water stood warm and stagnant.

Clinical symptoms typical in this epidemic suggested a mixture of hemorrhagic septicemia and black quarter. Microscopic and other tests revealed the causative organisms of these two diseases plus a third whose contribution to the epidemic is not known exactly. Animals died within 3 to 5 hours after the first indication of involvement. In a matter of 3 or 4 days over 30 head were lost. Thereafter the epidemic became less severe, but animals continued dying for a period of over a month. Unfortunately we do not yet know exactly what the cause was, unless it was the combination of three pathogenic organisms, two of which cause hemorrhagic secticemia and black quarter.

TABLE V

Female young stock statistics, 1948-49

Serial number	Breed	Number on 1st April, 1948	Born during the year	Purchased during the year	Transferred to milk stock	Sold	Died	Number on 31st March, 1949
1	Red-Sindhi ..	31	9	..	2	..	11	26
2	1/16 Jersey-Sindhi ..	1	3	..	1	..	2	3
3	1/8 Jersey-Sindhi ..	24	11	..	7	..	7	22
4	1/4 Jersey-Sindhi ..	5	6	..	2	..	6	5
5	5/16 Jersey-Sindhi ..	1	3	..	..	..	..	4
6	Jersey-Sindhi ..	..	..	..	..	..	..	..
7	9/16 Jersey-Sindhi ..	4	..	..	1	..	..	3
8	5/8 Jersey-Sindhi ..	5	..	..	3	..	..	..
9	3/4 Jersey-Sindhi ..	5	..	..	2	..	..	2
10	Jersey	1	..	2	1	..	..	2
11	1/8 Holstein-Sindhi ..	2	1	..	..	..	1	2
12	1/8 Brown Swiss-Sindhi	4	3	..	1	..	3	2
13	1/4 Brown Swiss-Sindhi	2	..	..	1	..	..	..
14	Miscellaneous ..	39	9	..	4	..	6	34
15	Murrah (buffalo) ..	26	11	..	8	1	8	21
	Totals ..	150	56	2	33	1	44	126
	Previous year Totals ..	158	64	0	39	12	21	150

R. P. A.

Table VI shows the number of heifers calved during the year, their age at freshening and their average weight at that time. Some improvement was shown in the age at first calving this year as compared to last. The body weight of

Table VI.

The average age and weight at first calving of 32 heifers transferred to the Milk Stock, 1948-49.

Serial number	Breed	Number of animals	Average age in years	Average weight in pounds
1	Red Sindhi	2	4·42	467·5
2	1/16 Jersey-Sindhi	1	3·40	580·0
3	1/8 Jersey-Sindhi	7	3·65	530·3
4	1/4 Jersey-Sindhi	2	3 41	590·0
5	9/16 Jersey-Sindhi	1	2 53	370·0
6	5/8 Jersey-Sindhi	3	2 54	418 3
7	3/4 Jersey-Sindhi	2	2 73	390·0
8	Jersey	1	3·20	320·0
9	1/8 Brown Swiss-Sindhi ..	1	3 50	545·0
10	1/4 Brown Swiss-Sindhi ..	1	3·58	655·0
11	Miscellaneous	4*	3·45	474·3
12	Murrah (buffalo)	8	3·26	879·2
	Totals ..	33	3·33**	514·1**
	Previous year totals ..	39	3·69	682·1

R. P. A.

*One animal aborted, hence only three are averaged.

**Averages of only 32 head ; see note above.

heifers at freshening this year was somewhat less than the year previous, mainly because general financial stringency in the Institute for the last two years forced a reduction in the concentrate feeds supplied to heifers the latter part of the year immediately preceding the one under report. It may be noted, however, that while their body weight at first calving diminished noticeably, there was a slight reduction in the age at first calving. There is presumably no reason to believe that the lower body weight was directly responsible for the earlier calving age. It is probable that there are other causes. In any case the earlier age at first calving is desirable.

MALE YOUNG STOCK

The number of male young stock on hand is indicated in Table VII. For reasons as yet not fully understood the demand for young male calves has greatly increased the last year or two. We have had three parties recently offering to purchase all of them, a thing which never happened before. Needless to say we are anxious to sell them as early as possible to avoid incurring any appreciable expense in rearing them, since we find it impossible to recover our money where bull calves are reared for sale as bullocks. Selling them within a day or two of age does not affect our milk production since all our calves are weaned at birth.

A comparison of Table VII with Table V indicates a somewhat larger number of male calves born this year than female calves. The sex ratio of the calves born this year in our herd was one female to 1·16 males.

Deaths among male young stock were not affected by the epidemic referred to above, in connection with the female young stock, because practically all male calves are sold within a day or two after their birth.

TABLE VII

Male Young Stock, 1948-49.

Serial Number	Breed	Number on 1st April, 1948	Born during the year	Sold	Died	Number on 31st March, 1949.
1	Red Sindhi ..	2	7	4	2	3
2	1/16 Jersey-Sindhi ..	..	7	6	1	..
3	1/8 Jersey-Sindhi ..	..	13	12	..	1
4	1/4 Jersey-Sindhi ..	..	5	4	1	..
5	5/16 Jersey-Sindhi ..	..	2	2	..	..
6	Jersey-Sindhi ..	..	1	1	..	..
7	9/16 Jersey-Sindhi ..	..	1	..	1	..
8	1/8 Brown Swiss-Sindhi	..	1	1	..	..
9	1/4 Brown Swiss-Sindhy	..	1	1	..	..
10	1/4 Miscellaneous-Sindhi	..	2	2	..	..
11	Miscellaneous	2	14	15	1	..
12	Murrah (buffalow) ..	3	11	12	2	..
	Totals ..	7	65	60	8	4
	Previous year totals ..	51	73	85	32	7

R. P. A. & H. C. S.

NEW CATTLE

In Indian Farming VIII (9), September, 1947, was published a brief account of the shipment of four Red Sindhi cattle from this Institute to the Bureau of Dairy Industry of the United States Department of Agriculture. The United States Government imported these animals as foundation stock for an intensive program of crossbreeding the Red Sindhi with the American Jersey. They are undertaking to produce a milk animal capable of tolerating the feed, climatic and disease conditions prevalent in the southern part of that country.

In exchange for these animals this Institute imported two young purebred Jersey heifers, one young purebred Jersey bull and one young Jersey-Red Sindhi crossbred bull from the Bureau of Dairy Industry of the United States Department of Agriculture on the 15th of January, 1949. We propose using these new animals to intensify and continue our program of Jersey-Red Sindhi crossbreeding, a program which we have been following for over 15 years. Each of these new animals has a much higher producing potential, as indicated by the production of its dam, than any Jersey stock we have used thus far in this work. From this fact, together with results we have obtained in the Institute herd so far, we are confident that by use of these new animals we will be able to show very valuable results from our work in the years to come.

ARTIFICIAL INSEMINATION

A few years ago a large number of services in our herd were a result of artificial insemination. This was done primarily to ascertain what were the major problems involved in this method of insemination within a well organised herd. From time to time we have attempted to extend this work beyond our own herd. Two or three samples of semen have been transported as far as Mirzapur or Bareily, but the results so far have been negative. We now have under consideration an arrangement for sending semen by air to Mysore, also correspondence is under way with an agency in Brazil for the transportation of semen by air to that country. It is quite possible to carry out artificial insemination where the donor and the receptor are as far apart as India and Brazil. Recent reports from Australia indicate that semen transported from U. S. A. was successfully used in inseminating Guernsey cows in Queensland. Table VIII shows the number of direct and artificial inseminations in our herd during the year.

TABLE VIII

Insemination statistics, 1948-49.

—	Institute zebu and cross-bred cows	Institute buffaloes	Outside cows	Total
Direct services ..	177	13	85	275
Artificial services ..	..	..	..	..
Totals .	177	13	85	275
Previous year totals ..	215	10	153	378

R.P. A. & H. C. S.

SHEEP

The number of sheep in the Institute flock is shown in Table IX. We are continuing to grade this flock for heavy yields of fine, long staple, crimpy wool. The introduction a few years ago of Corriedale blood has helped considerably in this development.

TABLE IX

Sheep statistics, 1948-49

Sex	Number on 1st April, 1948	Born	Sold	Died	Butchered	Number on 31st March, 1949
Male	22	15	3	18	2	14
Female ..	52	18	..	23	4	43
Totals ..	74	33	3	41	6	57
Previous year totals	96	32	..	50	4	74

S. E. B.

GOATS

The numbers of Jamna Pari and Bar Bari goats owned by the Institute are shown in Tables X and XI, respectively. Death losses continue to be high among goats because of the innumerable parasite enemies they have. So far we have no control measures for many of these parasites. We sold seven Jamna Pari and five Bar Bari goats during the year, but were unable to fill many orders which were received.

TABLE X

Jamna Pari goats statistics, 1948-49

Sex	Number on 1st April, 1948	Born	Sold	Butchered	Died	Number on 31st March, 1949
Male ..	5	8	2	..	6	5
Female ..	22	7	5	..	10	14
Totals ..	27	15	7	..	16	19
Previous year totals	36	24	..	2	31	27

S. E. B.

TABLE XI

Bar Bari goats statistics, 1948-49

Sex	Number on 1st April, 1948	Born	Sold	Butchered	Died	Number on 31st March, 1949
Male	14	14	1	..	17	10
Female	12	4	4	..	6	6
Totals ..	26	18	5	..	23	16

S. E. B.

SWINE

Since the termination, in June 1946, of the contract to supply the military with several thousands pounds of fresh pork each month and since the United Provinces Government discontinued, in the latter part of 1947-48, taking stud boars from us for distribution in the Province, we have had a very restricted market for breeding pigs and pork. For most of the pigs on hand during the current year, Table XII, no market was found (they were nearly all sold, however, shortly after the end of the year covered by this report). Accordingly, we reduced the number of pigs we are producing so as just to meet the small remaining market for breeding stock desired by private breeders and the small local demand for fresh pork. On this restricted scale, however, we will continue the work we have carried on for several years of improving these pigs for meat purposes by selective breeding.

TABLE XII

Swine statistics, 1948-49

	Sex	Number on 1st April, 1948	Born	Transferred from young stock	Transferred to adult stock	Sold to U. P. Govt. (boars)	Local sales	Butchered	Died	Number on 31st March, 1949
Adult stock	Male	24	..	5	..	..	12	2	7	8
	Female	56	..	3	..	..	11	26	6	16
Young stock	Male	9	38	..	5	..	13	..	9	20
	Female	10	41	..	3	..	13	..	10	25
Totals ..		99	79	8	8	..	49	28	32	69
Previous year totals.		191	151	139	139	52	28	32	131	99

I. N. M.

POULTRY

The lack of adequate feed has primarily been responsible for a further reduction in the number of poultry in our flock, Table XIII. Good poultry feeding requires whole wheat, corn, an animal protein and fresh green feed among other things. We are able to supply no wheat and no corn to our birds. The rationing of wheat for human food purposes makes it unavailable for use as poultry feed. Current prices of wheat, even if it were available for use for poultry, would make it prohibitive, considering the market value of birds and eggs. During the last year or two there seems to have been a noticeable increase locally in the human consumption of whole corn so that its price, even when available as it is occasionally, has been such that it could not be used economically for feeding poultry. We have had adequate fresh green feed, and substantially adequate quantities of skim milk or butter milk which are both sources of suitable protein. We also supply our birds with some blood meal which we make ourselves. On the other hand, the birds have been fed a ration containing large quantities of oil cakes and husks of certain of the dals. These are not the most suitable feeds for poultry.

BLOOD MEAL

Table XIV shows the quantity of blood meal fed during the present year. The noticeable reduction as compared with the previous year resulted primarily because there is less raw material available from which to make this meal. We continue, as the table shows, giving reasonable quantities to the pigs and calves, in addition to the poultry.

TABLE XIII

Poultry statistics, 1948-49

—	White leg-horns		Rhode Island Reds		Silkies		Ducks		Tur-keys		Geese		Guinea fowls		Chickens	Ducklings	Total
	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.			
Number on 1st April, 1948.	32	10	12	8	12	7	22	7	7	1	9	4	11	11	34	21	208
Number on 31st March, 1949.	16	6	4	8	2	1	11	5	4	1	3	1	6	5	42	..	115

I.N.M. and H.C.S.

F—Female, M—Male.

TABLE XIV

Blood meal, 1948-49

Poultry	1,002 lbs.
Swine	1,000 lbs.
Calves	498 lbs.
Total ..	2,500 lbs.
Previous year totals ..	8,448 lbs.

A.R. 9-49 : 200.

H. C. S.

REPORT OF THE AGRONOMY DEPARTMENT, 1948-49

By

G. D. Singh.

Staff

During the year several changes took place in the teaching as well as the farm staff. Dr. E. F. Vestal left for U. S. A. in March 1948. In the middle of the college session Mr. S. R. Upadhaya had to take two long leaves due to his ill-health and later on resigned. As the department had no full time teacher it had to take help from other departments. Mr. H. N. Mehrotra from the Biology and Mr. J. B. Chitamber from the Extension Departments shared the teaching of B. Sc. Agr. and Intermediate classes respectively. In the end of the college session Dr. A. K. Dutt joined the staff in order to teach B. Sc. classes. Dr. T. A. Koshy returned from the United States of America in the month of March and has acted since then as head of the department.

The farm staff also lost this year the services of Mr. S. R. Misra who resigned and joined Government service. Mr. G. D. Singh continued in the department as part-time teacher and acted as officiating farm manager. Mr. M. Siddiqi has been in charge of the vegetable section and its marketing.

Research and experimentation

The department continued its programme of research and experimentation which had been reported in the previous years. Two new experiments were included this year.

In the kharif season five experiments were conducted namely, juar varietal, bajra spacing, arhar varietal, jute varietal, sugarcane varietal and paddy varietal (transplanted); but unfortunately all of these experiments failed due to high flood.

Wheat.—The department agreed to conduct a wheat trial for Dr. B. P. Pal, Head of the Division of Botany, Indian Agricultural Research Institute, Delhi. Dr. B. P. Pal arranged to send twelve varieties of N. P. wheats and asked us to include two of the most promising varieties of wheat of this locality.

A randomized block experiment was therefore laid out in which the following fourteen varieties of wheats were included, namely, 710, 715, 718, 720, 737, 745, 758, 760, 761, 762, 764, 775, C13 and Vijaya (R9). The plots size was 18′ X 40′ and they were six times replicated.

On analysing the grain data there was found very high significant difference due to blocks and also high significance due to varieties. The yield data were as given below in their respective yield order.

760	755	715	710	764	761	762 & 9	758	720	13	737	718	745
76·0,	74·5,	735·,	73·0,	72·5,	71·5,	69·5,	67·5,	65·5,	64·0,	62·5,	60·5	51·5

The lines underneath the yields of wheat grain indicate the group in which there was no significant difference when the results were analysed statistically. These results as well as our observations of the crop during the period of experimentation would seem to show that some of the N. P. wheats in the first group should be preferred to the other N. P. wheats and also to the two local standard wheats (R. 9 and C-13).

Manurial Experiment—The department co-operated this year with the chemistry department to conduct a manurial experiment for Mr. J. C. Gideon..

THE FARM

The agricultural year under report was a period of rough sailing. Unusual difficulties were experienced. The effect of continuous rainfall, the high flood and the labour strike were the problems to face. It was a period of hard test for the management. However, the results of farming at the close of the year were not as bad as they were apprehended to be.

The total rainfall in the year was 18″ above the normal, recorded at the Agricultural Institute, Allahabad. The monsoon rains started in the end of the second week of June. The kharif sowing went ahead well, but due to excessive rains the crops after germination looked pale except cowpea, early maize and high land juar. In the end of August the monsoon rains were poor. This gave some chance to the crops to restore their normal growth, but the Jumna water began to rise from the 1st of September and by the 4th September submerged practically the whole farm except the Indalpur high land. The total loss estimated for the farm due to the flood was

about Rs. 54,000. This flood almost brought about a fodder famine on the farm after it receded. It very badly hit the Animal Husbandry Department. Quick growing emergency fodder crops (sunflower, maize and cowpea) were at once sown on the arm to ease the fodder crises. It helped to a great extent for the regular supply of green food to the milch cattle. The next attempt was to replant the previous Napier fields in the old furrows without any tillage operations; then later the old stubbles were cleaned and the new Napier crops were cultivated.

The area under rabi crops due to flood increased tremendously but the late monsoon rains made it possible to control all the area available for the season. The sowing of rabi crops was in time. The germination of all the rabi crops was excellent. The winter rains of 2·24" in November were very good for the rabi crops. The high humidity and cloudy days encouraged black rust specially in the wheat crop. As the black rust appeared late in the crop season, the damage was not much. On the whole the rabi season crops agriculturally were much better than many of the past years.

The following table gives the result of crops grown on the farm for the year 1948-49.

Crops	Area	Total yield		Total		Surplus or deficit
		*Mds.	Grain	Cost	Income	
Summer fodder (1)	1·20	2,143	..	1,016	2,030	+1,014
Grass & Sarpat ..	..	17,360	..	6,973	9,749	+2,776
Napier ..	25·40	34,433	..	11,995	28,957	+16,962
Guinea ..	1·30	1,014	..	302	763	+461
Vegetables ..	7·50	565(2)	3	5,366	2,932	−2,434
Juar fodder, etc. ..	106·40	7,448	148	14,914	10,685	−4,229
Cowpeas ..	52·0	4,289	8	4,353	8,283	+3,930
Maize { Kharif	17·2	849	13	1,151	1,531	+380
Maize { Rabi	2·5	1,506(3)	2	857	1,852	+995
Sannhemp ..	25·5	556	65	2,479	2,213	−1,266

*Quantity includes straw, potato vines etc.

(1) Bajra, cowpeas and sweet potatoes are included in summer fodder.

(2) The quantity mentioned above includes Lauki, cauliflowers, cabbages, lettuce etc., etc., the weights of which were estimated. Their actual cost and income are included in the figures mentioned above.

(3) In all, 21,268 green maize ears were sold and 15 maunds seed received. The weight of green ears has not been included in the above figures.

Crops	Area	Total yield		Total		Surplus or deficit
		*Mds	Grain	Cost	Income	
Misc. Crops (Winter) (4)	2 5	816		336	1,200	+864
Arhar & bajra ..	18·0	452	9 0	2,952	1,421	−1,531
Wheat ..	102 6	3,878	901	13,920	24,912	+10,992
Berra, etc., ..	55·9	1,448	843	6,146	13,160	+7,014
Early potatoes .	2·5(Y)	982	..	2,209	3,807	+1,598
Berseem ..	2·5(5)	728	..	1,256	1,414	+158
Lucerne ..	6·70	1,654	..	4,438	3,729	−799
Sugarcane ..	1·8	1,284	..	368	1,328	+960
Sunflower ..	14·6	3,228	8	1,215	4,126	+2,911
Oats ..	8·2	1,446	22	1,667	9,014	+7,347
				83,913=	1,32,106	+48,193

*Quantity includes straw, potato vines, etc.
(4) Miscellaneous or winter crops include radish, mustard and kudzu.
(Y) Potatoes 523 maunds and 459 maunds of vines
(5) The actual crop season begins from September to August. At the time of submitting the report the crop is still in the fields to be harvested.

The crop results this year show better surplus than that of last year in spite of the high flood. The crop results further show that the cost of production is coming down and the out-put increasing as compared with last year. This is chiefly due to the increase in efficiency of labour and to selection of more suitable implements for the farm.

This year again the Combine Harvest and Thresher machine was used to harvest most of the wheat area. As the area under wheat was more than in other years we could not use this harvesting machine for other rabi crops. The other rabi crops were harvested by hand. This machine has been a boon to the farm especially in the rabi harvesting period when labour was scarce and costly.

The position regarding labour, both permanent and temporary, was as follows :

	Total man-days.	Total cost.
1947-48 ..	36,345 ...	Rs. 34,314
1948-49 ...	34,767 ...	Rs. 38,486

The above figures show that farm labour is becoming scarcer and that the wages are rising. In spite of the increased wages we could not get the required number of labourers for farm work. With the present labour situation we shall have to modify our farming scheme and practices. *Firstly*, we should eliminate those crops which require plenty of hand labour and are less profitable. *Secondly*, we should use suitable improved implements to cover more area per man. *Thirdly*, we should use the most suitable machines such as the Combine Harvester and Thresher to cover large acreage with a minimum number of man days and in a shorter period.

REPORT OF THE DEPARTMENT OF HORTICULTURE FOR 1948-49

By

T. Dean.

Staff—Mr. W. B. Hayes remained on furlough during the year, Mr. M. Sharif continued as assistant lecturer and Mr. D. D. Srivastava joined the staff in July but continued only for 2 months.

The Department suffered a great loss due to flood. The total estimated loss was Rs. 23,560.

The growth and production of different fruit trees in the orchard was as follows.

Fig—The pollination of fig with syconiums of F. glomerata was tried again and was found to produce mature figs of satisfactory quality. The tying of *gular* (F. glomerata) was done during two different seasons, once in late May and early June and then again in early July. The pollination was not successful in the earlier period but there was very good success in the later period. Further observations are needed before anything definite could be said about the best time for pollination.

During his furlough in the states Mr. Hayes found out at the University of California about the work on induced parthenocarpy in the fig done by Dr. J. C. Crane by the use of hormone. The hormone used by him was para-chlorophenoxy acetic acid. It is used at the rate of 60 ppm. First dissolve in a little ethyl alcohol and then mix in water. It is sprayed at the rate of five gallons per tree, once to thrice during the pollination season.

A small amount of this hormone was received by us from the Eastman Kodak Co. through Mr. Hayes. Unfortunately it reached us rather late in the season and we could not do more than one spraying. Further studies in detail will be done next year. If it works successfully, it will be of great importance for it would not only be simpler than bringing in *gular* (F. glomerata), but it might lengthen the season, for it could be used even when no *gular* is available.

Mango—Mango crop was very poor though the growth in different flushes was quite satisfactory. This seemed to be due to the alternate bearing habit of mango.

The young plantation of mango at Indalpur made a very poor progress during the year. Many of the grafts were

found dead. So far no insects or disease have been traced out from the dried twigs, though the roots of many dead plants were found affected by termites, which might be a secondary infestation.

Litchi—For the first time a few fruits of litchi were produced in the orchard. The quality of fruit was very poor. It was very small with thin pulp and big stone, without any juice. It might be due to lack of early rains.

Citrus—The fruit set in citrus was not very satisfactory in most cases. About 10% of the fruits fell down during summer. As most of the trees were under water during the flood, of the total fruits that remained on the tree about 50% were spoilt. Many of the budded trees were badly damaged by the flood while the seedlings stood the flood well.

Guava—The guava orchard produced a satisfactory crop, but 2/3 of the total fruits were damaged by flood. It was observed that after the flood subsided the new growth started and a third fruiting took place in October.

The American guavas received from Riverside, California made very vigorous growth and seemed to be good plants for trying as stocks for guava. The quality of fruit was not very good.

Papaya—This was found to be the most profitable crop. During the flood the papaya orchard was very badly damaged and with the exception of a few plants most of the plants were killed. An attempt has been made to collect seeds to put under varietal trial next year and seeds have also been collected by selection for sex determination.

Insects and diseases—The insects as usual were present in the orchards. But their incidence was not very serious.

The common insects noticed in the orchards were.

(1) Mango hopper, (2) Stem borer of guava, (3) Catterpillar of lemon butterfly, (4) Citrus leaf miner and (5) Aphids. The last were noticed in some of the Attani trees and were successfully controlled by the use of tobacco decoction.

(6) Fruit moths were found to cause some damage to the citrus especially mandarine and grape fruits in September and October.

Among diseases Cephalopora was noticed in the guava orchard and was responsible for killing 6 trees.

Wither tip—This was not commoly noticed in the orchard except in a few twigs of Tangelo. The disease was controlled by pruning off the diseased twigs and painting them with Bordeaux solution.

Fruit Products—Preparation of products for different fruits like jelly, jam, marmalade, chutney etc. remained a major activity of the Department throughout the year.

It was noticed that jams when waxed like jelly keep for a longer period than otherwise.

The chutneys were found to keep good for a longer period if after filling them in the bottles a few c. c. of vinegar is added on top and left unmixed.

REPORT OF THE CHEMISTRY DEPARTMENT, 1948-49.

By

C. O. DAS, Ph.D.

During the year under report, in the beginning of the session, the following were the staff members of the department:

Dr. B. B. Malvea, Messrs. J. C. Gideon, K. K. Gupta and N. M. Chopra. The part time services of Mr. Houston, a short term missionary, were also available to the department until he left Allahabad in March 1949, prior to sailing for the States. His chief help to the department was to do the proximate Quantitative Analysis of the five samples of limestone of different kinds, which are now being used along with other analysed samples of limestone for 4th year practical classes.

Mr. Gideon officiated as head of the department during the absence of Mr. Brooks on furlough in America and until the return of Dr. C. O. Das. Dr. Das was on study leave abroad. He returned in the month of December after receiving the Ph. D. degree in Agricultural Bio-Chemistry and resumed duties from the 15th December 1949. Dr. Malvea continued teaching theoretical Agricultural Chemistry to 3rd and 4th year (Ag.) classes. Messrs. Gupta and Chopra did teaching mostly to the Intermediate classes, besides assisting in the B.Sc. practicals. Mr. Gideon was in charge of the teaching of both the 3rd and the 4th year classes.

Being short-handed in the teaching staff, no research problem was taken up. Teaching and regular routine work in connection with teaching and the supply of standard solutions to the Dairy and Animal Husbandry department continued to be the primary work of the staff of the department.

Mr. Chopra left the Institute in January 1949, to join military service. Unfortunately his post remained vacant until the end of the session, as no one was available to take up the job for the remaining college session.

During the last few years the department was depleted of its stock of Shroredter's bulbs, (an apparatus used in the estimation of carbon dioxide), due to breakage by students in practical classes. They could not be replaced from the market, as they were not available. Hence an entirely new method had to be found which could be handled easily by students and at the same time would give reasonably accurate results. Hutchinson's Method was tried and found to give quite satisfactory results.

REPORT OF THE BIOLOGY DEPARTMENT

By

W. K. Wesley

Dr. W. K. Wesley continued as the Head of the department. Dr. T. A. Koshy, who had taken study leave, returned from the United States after securing a Ph.D. degree in Plant Pathology. Dr. Koshy resumed the teaching of Botany and Plant Pathology along with Mr. H. N. Mehrotra who was dealing with these subjects. Mr. S. D. Mathur who was helping in the teaching of Biology left during the year to conduct research work at New Delhi. His place was taken by Mr. V. S. Saxena who also left to join in the Government Service. Mr. P. D. Srivastava was appointed in his place.

Botany and Plant Pathology

The rusts, which are very important and wide spread diseases on wheat, appeared very late, like last year. It was in the beginning of February when rusts appeared. It was difficult to see leaf rust, and striped rust was a bit common but Black steam rust developed widely. As the ears had already emerged by then so there was less loss to the yield of grain. The plants were all badly infected and thus the bhusa was not good.

Potato, an important cash crop, was this year completely free from Phytophthora infestans.

Entomology

Hieroglyphus and *Nephotettix* were not found in any threatening numbers. ¶ Work has been undertaken to study the efficacy of certain insecticides on stored grain pests and the effects of the treatments on the germinating capacities of the grains so treated.

REPORT OF THE EXTENSION DEPARTMENT, 1948-49.

By

C. MURRAY ROGERS.

Three years in the life of the Extension Department has made clear to the members of its staff how many and varied are the opportunities confronting them in the service of country people, and how difficult is the question of priorities when so many possibilities open up before them.

Dr. A. T. Mosher, as Head of the Department, a post he occupies along with his being Principal of the Institute, continued to give leadership and general directions to the whole project of Extension, to which should be added his consultative visits to the two Extension agents of the Department. Once again we have to report a visit of 4 months to the West which has resulted in the temporary appointment of the Rev. C. Murray Rogers as Officiating Head of the Department in the absence of Dr. A. T. Mosher.

Mr. W. R. Chester (B.Sc. Ag.) continues to act as Extension Agent to the North India Synodical Board and has recently moved his headquarters from Mainpuri to Shikohabad to enable him to be in closer touch with the farmers with whom he works. His Extension work over the last years in the introduction of improved seed, poultry, goats and farm implements, has encouraged the Department to start a centre for the supply of these on a larger and better controlled basis, which influence will radiate out to the villages from Shikohabad. In the Autumn of 1948, he and Mr. A. N. Singh went on a study tour to South India, which included visits to Poona Agricultural College, Katpadi Agricultural Institutes, and Martandam Rural Centre.

With his home at Takhatpur, Bilaspur, C. P., Mr. A. N. Singh (B. Sc. Ag.) is in charge of Extension activities which continue to grow in the area of work supervised by the Disciples Mission. He too has been concerned with the slow but essential process of persuading village people of the advantages of improved poultry, seed and implements, often by organising fairs for farmers, which enjoy an increasing popularity. He also takes his information to melas, or village fairs, where on more than one occasion he has been asked to speak.

Mr. J. B. Chitambar (B. Sc. Ag.) is the Extension Department worker in the immediate vicinity of the Institute itself. His chief concern is Research work in five villages situated a

few miles up the Rewa Road. There by the use of various methods in approaching the villager and his problems, Mr. Chitambar hopes to estimate the value of different ways and means in this educational process of getting the villager to improve himself, his home, and his land. The methods so far used include the publication of a village newspaper, yield competitions, and field demonstrations.

Dr. Mosher, Mr. Chitambar and Mr. Rogers have shared in the administrative work of the Department, and, with the assistance of the whole staff of the Institute, have again organised Short Courses for non-agriculturalists, and especially for theological students. The demand for such short courses seems to be increasing, and now includes requests for admittance from western workers as well as from rural workers of the country.

The number of requests for members of the Extension staff to visit various parts of India continues to increase. As well as the two study trips already mentioned, Mr. Rogers visited a number of centres of rural work in the South on his way to the Asian Conference of the World's Student Christian Federation held in December 1948, in Kandy, Ceylon, and later, at the invitation of the Bishop of Chota Nagpur, went to South Bihar to study conditions prevailing in the villages chiefly inhabited by Mundas.

The work of the Department goes beyond such separate items as have been mentioned and includes the Farmer's Fair, held again this year in February, the activities of the Christian Rural Fellowship of India, and the arrangement for lectures, given this year in January by a Japanese Y. M. C. A. worker, Miss Kiyoko Takeda. And under none of these headings come the very many letters from all parts of India and beyond asking for advice and information on a wide variety of topics affecting the life and work of the world's rural peoples.

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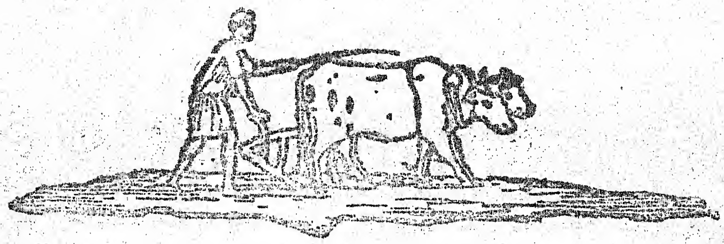
Irrigation and Drainage :—

THE

ALLAHABAD FARMER



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OUR EASTERN FRONTIERS

By

B. M. Pugh.

Our eastern frontiers extend eastwards along the Himalayas from Bhutan to the South-eastern limits of Tibet and South-west China, and then Southwards along the Patkoi range which lies to the west of Burma almost down to the eastern shores of the Bay of Bengal. Our eastern frontiers therefore border on Bhutan, Tibet, China, Burma and Eastern Pakistan.

East of Bhutan is a country or territory which is now known as the Balipara Frontier Tract. Although my home is not very far from this area, yet I knew next to nothing about it until I had the privilege to visit this area as an agricultural officer of the North-East Frontier Agency, the administration of which is under the Ministry of Foreign Affairs, of which our Prime Minister, Pandit Jawaharlal Nehru is directly responsible. I have called the opportunity afforded to me to visit this area a privilege. But when I was making preparation to go there, a missionary friend of mine said to me, "Mr. Pugh! do you know where you are going?" I replied, "Towards the Tibet border, of course". Then he asked me again, "Are you sure you will come back?" I said,

"I hope so". Then he said, "If you are going, I would advise you to kiss your wife properly before you go." But my tour programme had already been made and sent out to every one concerned, so that there was no option for me but to go. The first part of my journey from Shillong to Gauhati, was by car. From Gauhati I went by steamer to Tezpur, along the Brahmaputra river, a distance of about 100 miles. The scenery which I saw from the river that day was of a type which I thought was difficult to match anywhere. My travelling companion who was sitting in the front deck with me turned round to me and said, "Do you know that this scenery here is as good as Kashmir?". Since the man had been to Kashmir and I had not, I had no opinion to offer. But in spite of the scenery and the comforts which I found in the steamer, the thought of having to go to that unknown territory completely spoiled my boat trip. At Tezpur I went to see the Political Officer who was making arrangements for my journey to the mountains. He asked me how many coolies I would need for the trip. I very modestly asked for six. He, seeing that I did not know what I was asking for, asked me to check up with the Assistant Political Officer, who after careful checking up of what I should take, advised me to take twelve. Of course, twelve were necessary, as I had to have a tent, one month's ration, warm clothing, hiking outfits, food for the coolies themselves, etc. After the preparations had been made, I was taken in a jeep, and the accompanying Agricultural Inspector with the coolies went in a truck, to a place about 45 miles away from Tezpur at the foot of the mountains. The place is known as the Foot-hill camp. The camp is made every year after the rains are over, as during the rainy season wild elephants roam about the place and take pleasure in destroying it.

The Balipara Frontier Tract—

The next day we started off on foot and climbed through a dense tropical forest to what is known as the "Pestiferous" camp, a small open place at an elevation of about 3000 feet, which seems to cling to the side of a mighty mountain. The camp is so called because the place abounds with all kinds of pests: mosquitoes, various kinds of flies and all kinds of vermin.

The following day we continued the climb and came to an elevation of about 7000 feet. We were still in a dense forest but we had left behind the bamboo forests which appeared to me to be the wild elephants' paradise, as one could see everywhere the footprints of wild elephants, or bamboo

which had been trampled over, as it appeared, for the sake of pleasure only, or broken for their fodder. The air at this point seemed refreshing and invigorating as we were then in conditions approaching a temperate climate.

That night we started a big fire in order to keep ourselves warm throughout the night. Big logs of wood were collected to last us for the whole night. As we were standing around the fire that evening, some people came down the path which was barely visible in the forest and approached us. They were the first human beings we saw after we left the plains. These were hill-men from the North who had been employed by the Government to clear the forest path, by cutting fallen trees which had blocked the path and the shrubs which had grown and made the path almost untraceable since the beginning of the monsoon in early spring. The men had faces partially darkened with black soot and dirt, but one could see, as they approached nearer, the healthy red colour in their faces. One young man particularly who was one of the first to come out of the woods walked towards us in such a majestic manner that I thought he was a prince. His red face, his gait, his home-made boots and his somewhat red apparel at once caught my imagination; and after we had talked with him a little while through the interpreter I was tempted to ask him to give up clearing these forest paths and to come with me and be my personal attendant. But the Government law in those days did not allow any of these people to come into India, beyond the "inner line" which is a few miles only from Tezpur. So we satisfied ourselves by studying their clothes and their implements, while they in their turn examined ours.

The next day again we climbed up the mountains to 10,000 ft. which is the top of the ridges, and going over the hump we climbed down that same afternoon to a valley which is only 5,000 ft. above sea level. Here for the first time we reached a village; it was known by the name of Rupa. This is the beginning of the unknown territory whose agriculture I went to study.

At Rupa, I was met by two young medical officers of our Government who had recently been sent out to this area and who, when they saw me, took pity on me, and after a hurried consultation between themselves decided, I was told later, to send me back with a medical certificate that I was not fit to travel in that mountainous area. But when they were told by my accompanying Agricultural Inspector that I was not even

planning to take rest the next day but that I was proceeding farther, they were simply horrified at the idea. This may be explained by the fact that before I left Tezpur I was told how very cold the place I was going to would be, and so I thought it wise not to shave at all in order to keep myself warm. It was probably the sight of my beard which made them suspect that I would not be able to proceed farther.

I spent about a month in this area going up one range of mountains and down again to the next valley. The country is simply a series of mountains and valleys. The people who inhabit this area are known as the Mombas. Their culture is Tibetan. Their country is full of water mills which they use for grinding their grains. But each home has also a prayer wheel which is a replica of the water mill. Some villages have a large prayer wheel in which gongs are made to ring at regular intervals by the force of water.

The main crops are, to my surprise, wheat, barley and buckwheat, but they also grow some rice in the valleys, using wet terraces. They keep ponies and yaks. Their ponies are the most sure-footed of any ponies or horses that I have seen, and are admirably suited for the mountainous conditions of this area. The yaks (*Poephagus grunniens*) are large-sized animals with long hair and are very ferocious, but are kept by the Mombas for milk, and for breeding with a smaller animal known as *glang*, the hybrids from this cross being used for draft purposes or as beasts of burden. Yak's milk, I believe, is even richer than that of the buffalo. I developed a stomach ache within half an hour after drinking yak's milk, but it appears that the Mombas find no difficulty in digesting it, probably because they take their milk with their beer which they prepare from rice, maize or finger millet. But the Mombas also drink tea which is churned in bamboo vessels with their crude butter and a little salt.

The agriculture of the Mombas extends to an elevation of about 12,000 feet, but their yaks go up for pasturing to an elevation of 14,000 feet. The yaks rarely come down to an elevation less than 8,000 feet high.

I returned home after five weeks, and when I appeared before my officer to report about my return to headquarters, he remarked that I looked 10 years younger than five weeks before. Mountain climbing seemed to agree with me, for I found no difficulty in climbing Mount Tse La which is more than 15,000 feet high. It was in fact a real picnic, as we made tea at Mount Tse La out of chunks of snow and we used

for fuel live wood which very easily burnt as it probably contained much oil.

The Abor Hills—

The next trip took me to an area east of the Momba Country, a country inhabited by a race of people known as the 'Abors'. The best way to get to their country is to go to Pasighat, a small town situated at a place where the River Brahmaputra enters the plains of this country. Pasighat is about 50 miles from Dibrugarh, a town which can be reached by steamer, or rail or by air from Calcutta, a distance of about 1,000 miles. Geologists tell us that the arm of the sea at one time extended as far as Pasighat. The whole of the Brahmaputra valley therefore, from Pasighat to the sea, has been filled up within recent geological times.

The Abor people, it appears, have come from the North following the River Brahmaputra along its deep gorges and have settled in this mountainous region. Their country, therefore, extends almost from sea level to an elevation of about 25,000 feet. Namcha Barua, which is more than 25,000 feet high, guards this frontier in almost the same way that Nanda Devi, also about 25,000 feet high, guards the northern boundaries of the United Provinces. The way to Tibet through the Abor Hills is therefore across the snow-capped mountains which are negotiable only in the early summer.

The Abor people came under the British influence only very recently. Platoon after platoon of the British Indian army were exterminated by these people until they were finally subjugated about thirty-five years ago. But the Abor people are not by nature ferocious. They are, in fact, the most sociable people I have come across in any part of the world. During the one month that I toured in their country they organized folk dances in every village that I visited and very often forced me to join them in their dances which always lasted far into the night. I can still remember those half-clad figures, silhouetted against the fire, dancing in rhythm to the accompaniment of a leader who, raising his sword high and dancing in the middle of the group, at the same time chanted proverbs or composed poems befitting the occasion.

The agriculture of the Abor people living in the foot-hills of the Himalayas consisted mostly of the growing of hill rice (that is, rice grown without irrigation), maize and various kinds of millets. Their most common or most coveted domestic animal is the *mithun* (*Bos frontalis*), an animal similar in size to the buffalo but with features very similar to a large-sized cow.

But the animals are kept only for meat and are killed only on special occasions or for ceremonial purposes. This is common throughout the eastern frontiers along the foot-hills of the Himalayas and also in the Naga and Lushai Hills.

In my last trip to Pasighat, where I went to see the progress of the demonstration farm which I had started about two years ago, I met a number of anthropologists—men and women of the Government of India who have been sent out there to study the peoples of these frontier areas. These anthoropologists were equipped with phonographs and radio sets which, I understand, were meant to win the confidence of the people. But the Abors are such sociab le and loveable people that anyone who has their interests at heart can easily win their love and confidence even without the se gadgets.

The Mishmi Hills—

Further east, beyond the Abor country is a territory which is inhabited by the people known as the Mishmis. They represent another group of people who seem to be entirely different from the Abors. They appear to be sulky, unsociable and not by nature gregarious. Even their villages usually do not have more than three or four houses. These houses are usually built at a far distance from the main trade routes, and are long and narrow with a corridor to which all the rooms in the house open, very much like a railway carriage with its several compartments. The number of rooms corresponds with the number of wives which a man has.

Not wanting to pass along ungenerous remarks about this group of people without investigation, I tried to find out reasons for these traits. Some of the reasons appear to be these : (1) As a race, the Mishmis are more addicted to opium than perhaps any of the other tribal races in the eastern frontiers, (2) their country is also very un generous in that it is made up almost entirely of mount ains which rise to a height of about 15,000 to 16,000 feet or more ; and, as this part of the frontier probably receives the highest amount of rainfall in the whole length of the Himalaya mountains from Kashmir to the extreme limit of the Eastern Himalayas, landslides are a very common feature. Occasionally whole villages slide down the mountain and disappear into the Lohit River or its tributaries. In fact this Lohit river, during the rainy season, appears to be a bigger river than the Brahmaputra and many people have a mistaken notion that this is the real Brahmaputra river which rises in Tibet.

Life in this area is therefore very hard. Agriculture as we know it is non-existent. The country is very sparsely populated. But interestingly enough, the Mishmi women look more dignified than their neighbours, the Abor women. The reason probably is because women in this area are more sought for or bring a much higher price than in the Abor Hills. A girl in the Mishmi area usually does not marry a person unless he possesses a number of *mithuns* (*Bos sp.*) which is a measure of a person's wealth in this region.

The Tirap Frontier Tract—

Beyond the country of the Mishmis, our eastern frontiers turn almost sharply southwards, and the people who inhabit these parts of the frontiers are the Khamtis and the Singphos.

The Khamtis and the Singphos have settled in the low hills on the Indian side of the high ranges in which four countries meet: Tibet, China, Burma and India. At one time, it appears, the Khamtis held sway over the Mishmi area and all the wild territories not held by the Ahom (Assam) kings. Their sovereignty over these areas ceased only when the British occupied their territory. In order to ward off trouble in this area the British removed some of the leading families of the Khamtis from their homes and made them settle in other parts of the country, so that Khamtis are found today on the upper banks of the Brahmaputra river. The best method of travel in the Khamti area is by elephants.

The Singphos are, it appears, very closely related to the Kachins of Burma. Their territory in India lies on both sides of the upper Burma Road, better known as the Stillwell Road. At the time I visited this area, the Stillwell Road on the Burma side was not being kept up, so that there was no regular traffic between upper Burma and that part of India. Motor cars were able to go at that time up to 'Hell gate', a place a few miles this side of the Indo-Burma frontier. I am not sure why such a name was given to this place. The place is certainly hot and humid, but perhaps not more so than many parts of the foot-hills of the eastern Himalayan ranges. The surrounding area however abounds in leeches which appeared to be of two types. The bigger type is commonly found in marshes only. Having been warned of them, I had provided myself with several bottles of "skat", an American decoction which seems to repel all kinds of insects. I applied this rather generously to my stockings and also on all parts of my body which were liable to the attacks of these leeches. But the Agricultural Inspector who was going with me knew

nothing about "skat". So at the end of our first day of touring in the area, when I discovered that he did not have any leech bite in any part of his body, I asked him how he managed to keep them out. He unrolled his stockings and beneeth them were his wife's silk stockings which he had fastened up to his thigh. The leeches, he said, not finding a piece of flesh to which to attach themselves simply dropped away, probably with disgust, without bothering him.

The Naga Hills—

Beyond the Singpho area to the South, lies the country of the Nagas. The Nagas recently came to our attention because their country was invaded by the Japanese and because of their recent demand that their country be given full autonomy for at least a period of 10 years. At the end of this period, they contended, their relationship with this country will be more clearly defined.

But the term Nagas represents various tribes of people occupying the whole territory now known collectively as the Naga Hills. These tribes, about a dozen of them, almost all speak languages which are, it seems, very distantly related to one another.

The difficult nature of their country together with their head-hunting habit which has come down to within recent years has kept these tribes fairly pure. The Nagas of the Tirap Frontier Tract which is just south of the Singpho area and who are known to the outside world as the Konyak Nagas had very little communication with the other Nagas to the south of their territory. The most powerful *rajah* or chief of this area is that of the Namsang—Borduria area. This chief came into prominence during the last war when, it was reported, he declared war on the Japanese. The fact of the story seems to be that this chief had never allowed any one to enter his territory, but when he saw that fire was sometimes dropped even in his territory from those powerful "birds", the aeroplanes, he gave up resistance and allowed the British, and later the Americans, to enter his territory. He was therefore acclaimed as the friend of the United Nations whose country also joined in the fight against the Japanese.

The Nagas of the Kohima and Mokokchung area are making serious attempts now to bring all the Nagas together into one administration. These tribes are now in various stages of civilization. The present Indian Government also is making very serious attempts to educate not only the Nagas but all the tribal people who now occupy our Eastern frontiers.

But the Nagas themselves have recently exhibited a great thirst for education. They are going all out to establish schools in cooperation with Government in all the villages in the Naga Hills. This urge has come as the result of this last war when the Nagas saw up and down the Naga country the deadly weapons used by both the combatants in this last World War. It was then that the Naga realized how backward he is in comparison with the other people from other parts of the world. I believe, there is no other area in the whole of the Indian Dominion in which this thirst for knowledge is greater. The Nagas now take hold of every Naga boy and girl who studies in college and force them to teach in the village schools during the long summer holidays. But these college boys and girls are also paid very handsomely. I doubt, if there is any place in India where such temporary school teachers are paid as handsomely as they are paid in the Naga Hills.

The system of Agriculture of the Nagas is similar to the system found in most of the hill areas of this country. It is what is known as *jhuming* or shifting cultivation. The system consists of clearing a forest by felling all the trees and shrubs in the area, burning them and then sowing crops in the burnt area. Cultivation in this area is continued only for about two years and at the end of this period, the village clears a new space in the forest for cultivation. At the end of some eight to ten years they come back to the same area. This system of cultivation is very primitive and is responsible for serious erosion of the area and floods in the plains area of this country. Geologists tell us that the Naga Hills were at one time as high as the Himalayas, that is about 20,000 ft. or more. But to-day the highest peak in the Naga Hills is less than 10,000 feet high. *Jhuming*, the terrific amount of rainfall in this area, and the loose character of the soil are perhaps responsible to a large extent for the condition we find to-day in the Naga Hills. Surprisingly, the Angami tribe of the Nagas is alone acquainted with the art of wet rice terracing. This practice, it seems, has been followed by them for hundreds of years, and yet the practice has not gone beyond the Angami territory.* So while the yield of rice per acre in the Angami country is the highest in India, that in the other Naga areas where only unirrigated rice is grown is one of the poorest in this country.

Two reasons may be given as an explanation for this very high yield of rice in the Angami country of the Nagas. One is that the Angami Naga always grows his rice in well-built

terraces, the other is that the Angami Naga, like all the other Nagas, always locates his village on the top of a hill or mountain while his rice cultivation is on the lower slopes below or towards the foot of the hill or mountain. And as the Nagas keep all kinds of animals, such as pigs, dogs, goats, and chickens, in the village, all the refuse from the village ultimately finds its way to the neighbouring fields below and adds to their fertility.

Before I finish my observations about the Nagas, the most powerful of the tribal people of our Eastern frontier, let me tell you that amongst the Nagas it appears that a girl is more hard-working than a boy, or a woman than a man. The reason is probably because, in the age that is passing, the man in the Naga Hills is responsible for the safety of the village while the woman is busy tilling the soil. Men in the Naga Hills, therefore, used to opend their time in the village or near the village Council House, so that, when an alarm was given, every man and young man available in the village could go out and meet the enemy. It is for this reason that the Naga village is always at the top of a hill or mountain. An alarm is given by the beating of the wooden drum which is about 25 to 30 feet long, and the sound can be heard for miles around.

The Manipur State—

South of the Naga Hills is the Manipur State through which runs the great highway between India and Burma and the conntries beyond, known as the Burma Road. This country is not as high as the Naga Hills territory and produces a surplus amount of rice of which this country (India) is so very much in need. While the Manipuris are considered a distinct tribe, yet as the state is also inhabited in the North by a number of the Naga tribes and in the South by the Lushai or Mizo tribes, there has been such an admixture of these tribes that it is difficult to single out any individual in the state who may be considered as a pure Manipuri.

The Lushai Hills—

South of the Manipur State is a country known as the Lushai Hills. This territory consists of parellel ranges of hills which run North and South and extend almost as far south as the Bay of Bengal. The hills are not as high as the Naga hills but are almost as steep, so that communication between the different ranges is quite difficult. Agriculture in this area is also quite primitive as it consists mostly of *jhuming*. Because of the difficult nature of their country, it seems many of the young men of the Lushai Hills have

taken up military careers. The men are generally very sophisticated, while their women are very lovable. As the Lushais have had an earlier start than the Nagas in getting modern education, they are, on the whole, better educated than the Nagas. They are to-day the most advanced of all the tribal peoples I have described so far. While there is every prospect that the Naga s will catch up, the Lushais also have not yet slowed down their pace in their search for education. The Lushais claim a church membership of 87 per cent. out of their total population.

Conclusion—

I have in the course of this article given a good many names of the tribal people inhabiting our eastern frontiers, but the list is far from complete. The small territory of India which I have called the Eastern frontiers is a continenr in itself. People inhabiting these regions even to-day consider themselves distinct nations, and it is for that reason that I have on several occasions in the course of this article called their little territories, countries.

It is my belief that one of the biggest problems which faces India to-day is Indianization of all the races and people of this country. The sooner we shed our parochialism, tribalism, racialism, provincialism and even nationalism the better it will be for this country and for the world. There is no room in this country for more than one nation, as there is no room in this planet for more than one world. I, therefore, look forward to the day when all of us, East or West, North or South will become one.

EXPERIENCE IN INDIA WITH THE COMBINED HARVESTER-THRESHER

BY

MASON VAUGH.

Agricultural Engineer, Allahabad Agricultural Institute.

Food grain is perhaps the most important single item in the food of people all over the world and particularly is this so in India. A large proportion of the land is occupied by food grain crops and a large part of the total agricultural labour expended on the farms of India is used for the growing of food grain.

Of the various items of labour involved in producing a maund of food grains, one of the large ones is that of harvesting and threshing. Not only is this operation important because of the amount of labor it requires but also because of the necessity of getting the work done in a short time. Once the crop is ripe for harvest, delay results in loss of grain and deterioration in the quality of grain and straw. If rain occurs, the crop may be heavily damaged or a total loss. Even after harvesting is complete and the crop is on the threshing floor, there is still danger of damage or loss from the attack of insects and rodents, from damage by rain and from total loss from fire, until threshing and storing away is completed. The harvest time is always a time of hurry and anxiety until it is completed.

The Agricultural Institute has had to face these difficulties along with other farmers and zamindars in India. In its own work, there has always been difficulty in getting enough labour to do the harvest by hand methods. With increasing industrial development and with the demands of war installations in recent years the difficulty of getting labour has increased. Along with other commodities, the price has also increased so that in terms of agricultural production the cost of hand labour has not decreased markedly with inflation of the price of grain.

Visitors who have come to us for advice have also called our attention to the need of improved methods of harvesting. There have been repeated enquiries for some sort of bullock-drawn device or mechanical method of harvesting which would enable them to get their harvest in with the labour available, whether it lowered the cost or not.

It is also true that some authorities trace the real beginning of the agriculture revolution to the invention of the reaper and the power threshing machine. It is true that some progress had been made in the design of better ploughs and other simple cultivating implements but they had not attained wide popularity or awakened enthusiasm. It was of little value to a man to grow more crop than he could harvest and care for. It is said that the limiting factor in agricultural production in America where there was ample land, at the time of the perfection of the reaper, was the area which could be harvested. The development and wide marketing of the reaper gave a great impetus to the development of better field implements, a development which is still in progress throughout the world and which has already profoundly affected the course of civilisation.

It is but natural therefore that the Institute should have studied the possibility of improving methods of harvesting and threshing. Very early in its existence a sweep reaper was secured but its use was soon abandoned. Later another was secured and tried for some time but it also did not prove of enough advantage to justify its continued use and it was also abandoned. Along with the first reaper or about the same time, a threshing machine driven by power was secured and used for some years but it was made largely of wood and did not stand up well. Later, about 1928 another thresher, this time built entirely of steel, was secured and it has continued in use till now. It did a satisfactory job of threshing and of separation of grain and straw but the attachment on it for making *bhusa* (chaff) was not successful and had to be removed. This machine solved to a considerable extent the problem of threshing but left the problem of harvesting—the cutting of the crop in the field and the bringing of it to the threshing floor—untouched.

In western countries the binder, variously known as the self-binder or the harvester-binder, which not only cut the crop but gathered it into sheaves and bound the sheaves with twine, soon displaced the reaper. This became the standard method of harvesting in the areas where mixed farming on a moderate or small scale was practised and where it was desired to save the straw. With the development of areas where wheat was grown on a really large scale and where there was little or no livestock production to utilise the straw, saving the straw became only an embarrassment; for these areas the header harvester was developed. This machine with a cutter bar 12' to 14' long was operated to cut just below

the heads of the crop, leaving most of the straw standing and delivering the heads with short straw into wagons or "barges" which travelled along side at the same rate as the header. Where large areas in big fields were to be covered and where the straw was of no value, these headers were very useful. They got the grain at a minimum cost and the cost of threshing the heads only was much less than when the whole of the straw was put through the machine. They never had any chance of adoption in India because they were not adapted to small areas and because of the value of the straw.

A few binders were imported and tried in India. So far as cutting and binding the crop was concerned, they functioned all right but were not adapted to small fields and the twine was a difficulty. A special manila or sisal twine not made in India was required. The importation of this twine and ensuring that it was available in the necessary quantity without having funds invested for a long time in surplus twine proved to be impracticable and the binder never attained any real popularity.

Even before the binder was perfected, a few combined harvester-threshers were built in western America, machines which cut the crop and fed it directly into the accompanying thresher where it was threshed and the grain cleaned, the straw being discharged at the back and left on the field. These were large and expensive and attained little popularity until the internal combustion engine was developed to a high state and applied to the small and medium sized tractor. In the early 1920's small—by previous standards—harvester-threshers were designed and brought to a fairly high state of perfection and came into wide use. Their use spread rapidly so that now more grain is harvested in western countries including South America and Australia, by combine than by all other means put together. More recently smaller ones, even as small as 42" (three and one-half feet) cut machines have come into use. These are generally pulled by, and powered as well, by a tractor. For the farmer having a tractor already, they cost not a great deal more than a binder and are decidedly preferable, in some cases making it possible for one man alone to harvest fairly large areas and to thresh the grain as he goes along. These machines, like the binder, are pulled behind the motive power, cutting along the side. They knock down considerable grain getting started. In very large fields and where labour is very expensive, this can be tolerated. In small fields and where the value of the grain is high compared to the cost of labour, this is not economical and the field should be started otherwise.

A still more recent development, within the last 10 years, has been the "self-propelled" combine. This has the same features as the older machines in that it cuts and threshes the crop but differs in that one engine on or in the combine itself furnishes power both to operate the machine and to move it about. Not requiring a tractor to pull it, the cutter bar can be put in front of the machine and it can thereby cut its own path through the crop. While its technical success is no longer questioned, there is still question about its economy as compared with the pulled type. The minimum size so far available is about 7' wide as this is the narrowest wheel track which will give sufficient stability.

The Engineering Department of the Institute has been watching the development of the combine for some years as possibly offering the best solution to our problems; at least it seemed the one thing most likely to be adaptable to Indian conditions generally. The small self-propelled combine seemed to be sufficiently promising in 1944-45 when I was on furlough, to justify placing an order for one. Accordingly, with a grant from the U. P. Government to cover half the cost, a Massey Harris Self-Propelled Clipper was ordered. Due to shipping delays and other causes, it was not received in time for the 1947 crop season but was used in 1948 and 1949.

In 1947, the U. P. Government had an International Harvester No. 62 pull type with its own engine, received as part of land lease and not in use. This was borrowed for the season and used for preliminary trials. It proved to have sufficient range of adjustment of the cutter bar to cut to the desired level and the threshing mechanism functioned satisfactorily. However, it is essentially a heading type and when cutting very short stubble and especially in lodged crop, the feeder did not work very satisfactorily. The feeder auger was removed, a sheet of iron, bent to allow the crop to slide into the elevator canvas part of the feeder, was added, and a seat fixed behind the cutter bar. A man sittng on the seat and using a simple bamboo was able to move the cut crop from the part of the cutter bar not behind the elevator canvas fairly satisfactorily and the machine worked 126·75 hours between 12th March and 14th April, 1947. During this time some 49·28 acres were harvested with a yield of 505 mds. of grain and 689 mds. of straw. We had hoped to carry further trials with this machine in the next year but the U. P. Department of Agriculture asked for its return so only the one year's results with it are available.

Our own machine was received in time for the 1948 harvest season and was used on wheat for a total of 93·5 hours on an area of 24·68 acres giving a yield of 194·75 mds. of grain and 388·75 mds. of *bhusa.* The length of time the machine could be used both this year and in 1947 was limited by the very small amount of petrol and tractor fuel available.

Again in 1949, the Massey Harris clipper was used on our fields for a total of 20 days covering 53·8 acres with a yield of 478 mds. of wheat and 173½ "cartloads" of *bhusa.* (The weight of *bhusa* is not available.) Further details of operation are shown in the table below:

TABLE NO. 1.

—	1947	1948	1949
Area harvested—(acres) ...	49·28	24·68	53·8
Grain threshed—(maunds) ...	505·00	194·75	478
Bhusa	689 mds.	388·75 mds.	173½ carts
Days worked	126·75 hours	11 days	20 days
Petrol consumed	89 gal.	82 gal.	171 gal.
Power kerosene	133 gal.	...	...
Lubricating oil	...	...	8¼ gal.
Grease, etc.	...	...	13 lb.
Labor for operation of machine ...	237 8 3*	127 13 6	256 8 3†
Cost per acre	11 8 9	17 10 7	26 12 6
Cost per maund of grain ...	1 2 2	2 3 10	3 0 3
Cost of harvesting hand per acre ...	...	10 11 10	...
Cost of threshing per acre, (stationery thresher).	...	5 14 10	...
Cost of harvesting and threshing ...	...	16 10 8	...
Cost per maund of grain, threshing only (with old thresher).	...	0 11 10	...

* does not include handling straw.

† includes men loading straw.

In all three years operation was hampered by the fact that the machines were new to the operators—fresh operators had to be trained each year, partly because of resignations—and by the fact that the machines were operating under conditions different to those for which they had been designed and tested. Neither of the machines had any arrangement for saving the straw and much time was consumed in installing and operating mechanisms for this. The machines were also hampered by the fact that in all three years there was considerable lodging of the crop. Some plain hard luck happened, as for instance in 1949 near the end of the season the magneto developed a rare type of fault and could not be repaired or replaced in time to be of further service.

From the start, the importance of saving the straw was recognised. The first year, the straw was saved by putting behind the machine a large canvas tarpaulin which was fastened to a piece of angle iron bolted to the rear of the combine. The tarpaulin was allowed to drag on the ground and the straw dropped from the machine on to it. Two men with pitch forks walked beside the tarpaulin and saw that the straw did not pile up enough to interfere with easy discharge from the machine. This worked quite well so far as catching the straw was concerned. As the machine came round each time, it was stopped at a corner and the straw raked off into a pile. This delayed the operation quite a little. The cost of loading the straw from these piles on to carts and the loss of straw, especially chaff which could not be collected, was enough to make the method rather impracticable, on economic rather than technical grounds.

We were able to devise a better arrangement for the Clipper. There was a chain sprocket on it from which a drive could be conveniently taken to a light shaft which was added to drive a straw carrier. The straw carrier, a simple wooden platform with a driven roller at the machine end and an idler roller at the upper end, was fitted just below where the straw and chaff are discharged at the back of the machine. On the rollers, a carrier belt consisting of three strips of *nawar* (canvas webbing) with wooden slats at intervals of about 9" was fixed. This was driven by the driven roller and continually carried the straw and chaff falling on to it up and off the back end.

In addition a hitch was fastened to the back of the machine to which carts could be attached. Three carts with two types of straw racks or frames were prepared to interchange with each other. When hitched to the back of the

combine, these effectively caught the straw as it came from the machine. It was necessary to have two men on the cart to distribute and trample down the straw. Interchangeable tongues and yokes were arranged which could be easily fixed to the carts to allow a pair of bullocks to take them away. It took about two minutes to detach one cart and attach another and get going again, if the men worked fast. When the straw was light and the distance hauled short, one pair of animals could handle the straw. When the distance was more, the straw heavy and the machine operated well with no stoppages, two pairs were required and a fourth cart would have been an advantage.

This method of handling the straw was effective and reasonable in cost so far as handling the straw was concerned, definitely better than the canvas method. It did hamper the operation of the combine. Without the trailing cart, the combine can be backed, worked into corners and handled very effectively to get all the crop. With the cart, it could be backed only very short distances without getting into difficulties with the cart. It was only possible to turn to the right because on a left turn the combine bag chute was fouled by the cart. This would have been remedied by a longer hitch on the cart but this would have entailed a longer straw carrier, more spillage at corners when the turning combine tended to swing the carrier to one side of the cart and other difficulties. At present no basic improvement in the arrangement seems possible or at least feasible.

We propose next year to improve the straw carrier by substituting a shaft with sprockets for detachable link chain and chain and slat arrangement for the rollers and webbing straw rake. Most of the stoppage in the field and the cost of field repairs was due to trouble with the straw carrier. However, it is considered that the trouble was due to poor construction rather than bad basic design. Using a positive drive chain will also probably make possible the raising of the back end of the elevator which will be desirable. Otherwise no basic change in the arrangement is contemplated.

While more costly, the self propelled type of combine seems definitely the more desirable of the two kinds tried. No way was found of readily attaching the cart behind the pull-type machine nor was there any convenient way to fit a straw carrier. While in the table, the cost per md. of grain and of harvesting and threshing per acre is shown as lower with the pull type, it should be remembered that the difference

is made up in the greater cost of handling the straw with the pull type. It is also to be remembered that costs of labor and materials rose steadily during the period of the tests which would account for part of the difference.

Does the combine make *bhusa*? The answer is "no" in each case. The straw is broken somewhat, but less than by the stationary thresher and even the stationary thresher does not make acceptable *bhusa*. This is a disadvantage for which no immediate remedy is seen. The problem is still being studied as to how a really effective *bhusa* making attachment can be added but so far no solution has been found. The straw is treated in two ways at the Institute for making it into acceptable feed. Some of it, most of the combine straw this year, was put through a silo filler (large chaff cutter) along with green napier grass or other succulent fodder. Being mixed with the fodder and absorbing some of the juice of the fodder, the cattle ate it even when not as finely broken or cut as is *bhusa*. Part of it was put through a paper hammer mill grinder. When properly done this will make a premium grade of *bhusa* which is clean and very acceptable in the bazaar. It is also possible to have bullocks trample the straw after the grain is removed. It is commonly thought that the *bhusa* breaks better when the grain is still present and this is probably true but it is still possible to break it by trampling without the grain. The use of a "norag" or an "olpad" thresher for breaking the straw will also hasten the process and it is quite in order to use them so. Making the *bhusa* can be spread over a longer period as there is less damage to it from rain, less likelihood of fire being set to it and it can even be stored unbroken and can be broken after the rains if necessary. Unbroken straw will take slightly more storage space than *bhusa* but otherwise there is no difficulty.

The combine can be used not only for combining but for stationary threshing. We have used both the combines in this way. The No. 62 was fitted with an improvised beam and hitch for bullocks and taken about a mile where it was used for threshing several acres of crop, including wheat, barley and gram, all of which were satisfactorily threshed. The Self-propelled went under its own power. The only adaptation necessary was the removal of the reel and the elevation of the feeding table to a convenient height.

While various costs are given in the table, they should not be considered too accurate or very closely comparable. While

the costs per acre are quite different in the three years, it should also be realised that different machines were used and that the arrangements were different and that different items are included which are not strictly comparable. Particularly the cost of handling the straw is not clearly shown. In this trial period, when many adjustments and some modifications had to be made to the machine, costs are higher than they should be later. As changes were made in procedure as well as in equipment, it is difficult to get exactly comparable figures.

That this is true is shown by two possible comparisons. In 1948 the cost of labor per acre for operation of the machine was Rs. 5·1; in 1949, it was Rs. 4·76. In 1948, the consumption of petrol per acre was 3·3 gallons, in 1949 it was 3·23 gallons. This would indicate that the differences were due to factors which were not directly comparable. (The same machine was used in these two years).

Care should also be taken in comparing the cost per maund of grain. This is influenced by so many factors. The cost of covering an acre will depend very little on the yield of grain, much more on the yield of straw but will not be directly in proportion to either. To illustrate, if the yield in 1948 had been one maund per acre, the cost would have been about Rs. 17 per maund instead of 2/3/10. On the other hand, if the yield had been 25 maunds, the cost per maund would have come around 11 annas.

The value of the method cannot be assessed directly on the cost per acre or per maund of grain. In certain tests made in England, it was reported that extra grain saved in the direct harvesting process would pay for the whole cost of harvesting. Again, 4 to 5 men working the combine could carry out the whole process including cutting, threshing and delivering the grain and straw to storage at the rate of 4 to 5 acres per day or at a man-day labor demand of around 1 day per acre. Hand harvesting requires around 10 to 12 man days per acre and threshing with bullocks requires about as much more. When there is a shortage of labor, this may be more important than costs. Also, the harvest being one of the times when labor is in demand and when it is necessary to close schools and to call men and women from industrial employment who are not needed at other seasons, the adoption of the combine may smooth out demand for labor and reduce interference with industrial employment and production.

We are not prepared at present to say that the combine is ready for general country-wide introduction into the villages.

It is, with the few adaptations noted, ready for the use of large farms and for the beginning of experiments for use of it as a contractor's machine in the villages. While it can doubtless be improved for these purposes and can be better adapted to the villages, it appears at present to be the only harvesting machine in sight which seems really adapted to general future introduction. It seems highly desirable that further experiment in addition to the continued use of the combine at the Institute, should be made with the definite object of making it available in some way to the ordinary small farmer in the villages. We intend to continue our experiments and are confident that we can in future get much better results than we have so far accomplished.

PLANT PROTECTION SERVICE IN INDIA

By

Dr. U. N. Mohanty, M. Sc. (Cal.), Ph. D. (Lond.), D. I. C. (Lond.), Assoc. I. A. R. I. (Delhi).

Mycologist to the Government of Orissa, Department of Agriculture, Cuttack.

Every cultivator who puts so much of his labour and the care into growing a crop, is always anxious to save it from the dangers of pilferage and destruction. A farmer who is careful, always keeps guard against thieves and puts a hedge around the field for checking the entry of destructive animals, such as stray cattle or wild animals. Sometimes, he is also engaged in driving out monkeys and birds which may also spoil the crop. These are instances showing how a cultivator is really alive to the dangers that might come upon his crop and how he takes steps against such enemies. Cattle, monkeys, birds or wild animals are enemies against which a cultivator does not find himself very helpless.

But there are so many other enemies small and big, visible and invisible against which a cultivator, under the present state of his knowledge he is really helpless. During the period between the sowing of the seeds and harvesting of the crop, the plants are left exposed to the mercies of nature. During this growing period, many natural calamities such as flood, rain, drought or cyclone may occur; and against these, no human efforts can prevail. Similar is the case with pest and disease outbreaks. The cultivator may see the insect pests in the field and may know the cause of the outbreaks, but his ignorance about their life and behaviour makes him feel helpless. Still worse is the case with plant diseases, where the enemies are invisible and the cultivator does not know why such epidemics happen. Under the circumstances, he resigns himself to his fate in the same way as he does in case of a flood or cyclone.

But now researches on insect pests and disease organisms have advanced our knowledge and we know many control measures which are practicable under our field conditions. Our farmers should only get familiar with common insect pests and plant diseases and help themselves better to protect their own crops. In foreign countries researches have progressed far, and organisations have been long set up to control these visible and invisible enemies against which our farmers have so long pleaded their helplessness and ignorance.

In India, due to insect pests and plant diseases, the aggregate loss in our crop plants is about 20 per cent. or nearly 8 million tons of food grains per year. These losses may vary from crop to crop or with the type of insect or disease. Losses occurring to our stored grains are also enormous. So, if a part of the losses caused by insect pests and diseases can be avoided, India will have most nearly sufficient food. Many of these pests and diseases have wrought havoc in the past. In 1938-39, the red-rot epidemic swept over the sugarcane fields of Bihar and U. P., and serious loss occurred due to the disease. The last Bengal famine in 1943 is also ascribed partly to the failure of paddy, which again was due to a plant disease. In 1946-47, about two million tons of wheat worth Rs. 60 crores were lost due to black rust disease, which spread over the C. P. and Central India states. The effects of this epidemic have been recurring, in the sense that as a sequel to this fungous disease the cultivators have been forced to cut down the wheat area and the acreage fell from 29 lakh acres in 1946-47 to 18 lakh acres in 1948-49 in the Central Provinces alone. Thus there are instances of disease epidemics occurring frequently and causing havocs in one part of India or another.

Most of our common diseases can definitely be controlled and the measures that are to be taken against them are often feasible and economical. Similar is the case with regard to the pest epidemics. People are quite familiar with the insect pests swarming over the cultivated fields and destroying the crops like wildfire. The invasion by locusts is very much feared by the cultivator. In India, they used to cause serious losses to our crop plants. The locust control organisation, which was set up in the year 1939, investigated suitable control measures especially in the breeding areas of the locust and has been able to combat very successfully this menace. However, such frequent pest and disease epidemics have mobilised the opinions of our thinking public that steps should be taken to avoid such disastrous epidemics, which may sometimes lead to a famine. The Bengal Famine Enquiry Commission also realised the cause of such crop failures and suggested that plant protection should immediately be taken up as an important branch of crop production. On the basis of their recommendations, a Directorate of Plant Protection has been established at the centre from the year 1946 and these services are now being organised in different provinces.

The Plant Protection Service is to protect the plants from any possible attacks by insect pest or diseases. It has to control effectively the pests and the diseases that are already

occurring in the country and also to save the crop from any unforeseen attacks. To avoid the latter, the entry of new insect pests or disease organisms into our country is to be prevented. In the past, unrestricted entry of plants and plant parts has allowed many harmful agents to get established in India. The familiar examples are certain obnoxious weeds, such as prickly pear, lantana, and water hyacinth. In the same way many new insect pests and diseases have come to India and they stand at present as a potential danger to our crop plants. If further entry of such harmful organisms is to be prevented, effective quarantine regulations have to be formulated and strict inspection have to be enforced on the plants and plant parts that are imported to this country. Thus the organisation of a quarantine service has become one of the most important functions of the Central Directorate. Nevertheless, the control of existing pests and the diseases which are already causing serious losses to our crop plants is also equally important.

Considering the vastness of India and the local distribution of pests and diseases, it is never feasible or financially practicable, that the centre take direct responsibility for this. In this matter the co-operation of the respective provincial governments is necessary. Provinces have to assess what insects and diseases are important in their areas and against which control operations are badly needed. Moreover, they have got to take steps against the entry of new pests and diseases into their provinces. Thus the organisation of a regional or provincial plant protection service has become a necessity. The centre may help by way of finance, technical advice, provision and supply of machinery and chemicals. It may also take up the responsibility of training the plant protection staff who need technical knowledge and skill. In these matters the central organisation is doing its best. It is establishing a Bureau of Information for the collection and dissemination of information regarding the plant protection work now done in various parts of India. It has also established a central pool of power-operated plant protection machinery at New Delhi, with sub-stations at Asansol, Ajmer and Nagpur. In case of epidemics it is proposed to supply the machinery from the nearest centre. Further, it is also helping to get machinery, insecticides and fungicides which are not available in India at the moment and is also prepared to undertake the training of personnel, if so required by the provinces.

The Provincial Plant Protection Services on the other hand are primarily entrusted with the actual execution of the control

operations. Although the work of these services may seem to be more or less mechanical, the objectives and the policies of the provincial organisations are as varied as those at the centre and they may be noted as follows:—The Provincial Service is (1) to undertake actual control operations in certain areas, (2) to demonstrate, and fully and convincingly explain to the cultivators the efficiency of a control measure, (3) to initiate and organise work in the village areas and to provide necessary technical assistance, materials and equipment, (4) to survey the insect and the disease position in the province, (5) to undertake field experiments on the efficiency of two or more control measures against the same pest or disease, (6) to maintain watch and ward service for the detection of pest and disease attacks and to prevent the entry of new pests and diseases into the province.

Thus, heavy duties have been assigned to the provincial plant protection organisations. Apart from the actual control of the pests and the diseases, the education of the public seems to be more important, as, in the long run, Government can not possibly afford to spend a large part of their revenues on these items and the cultivators have to do it at their own cost in their respective fields. If this end is not achieved and the cultivators do not willingly undertake these measures as a part of their agricultural routine, the main purpose of this service will be defeated. In order to achieve these objectives and to guide and execute these scientific operations, various provinces are setting up their plant protection services. But in view of the importance of the scientific knowledge and the skill that are involved in employing scientific results in practice, and in view of achieving so many other important objectives as stated above, the provinces have rightly taken up the plant protection services in association with qualified entomologists (to deal with insect pests) and mycologists (to deal with plant diseases).

During recent years, the manufacture of various insecticides and fungicides has revolutionised the methods of insect and disease control. Everybody is now familiar with certain insecticide such as D. D. T. and Gammexane. There are also many others on the market which go by many trade names. So it is a matter of technical detail for the plant protection service to test and decide how and when and in what dosages these insecticides are to be applied in the field. Similar is the case with regard to the fungicides. Most of the seed-borne diseases are now effectively controlled by seed dressings with mercuric compounds such as Agrosan, Ceresan and Semesan.

Bordeaux mixture in a dried from is now available in the market and other copper compounds such as Perenox are also there as a substitute for Bordeaux mixture. Some weed-killers have also been manufactured. Therefore it is important for the plant protection service to make rapid field trials of one or more of these chemicals against a specific pest or disease and to draw up a spraying programme for the province.

Some of the provinces such as the U. P., Bombay and Bengal, where the scientific service has received due appreciation, have already organised efficient plant protection measures. The others are also favourably considering the establishment of such a service. However, these three provinces, have shown substantial resuls in plant protection. In the U. P., control operations were directed against the pests and the diseases of sugarcane and against the insect pests of Citrus fruits and the mango. In Bombay, operations were also directed against the pests and the diseases of sugarcane and also against the rice grass-hoppers. As a result of grass-hopper control, Bombay has saved 2 lakh maunds of paddy, worth 22 laks of rupees. In Bengal, potato plants were sprayed against the blight disease, bringing a return of 25,000 maunds worth 2½ lakhs of rupees. Thus measurable progress has been achieved by some of the provinces and this is an appeal to the cultivators in general to initiate interest in these matters and to try to know what these scientists are doing in their fields and why.

THE GUAVA: PRIME FRUIT OF ALLAHABAD

By

VIRENDRA CHANDRA, M.Sc. (AG. BOT.)

Research Scholar, Department of Botany, University of Allahabad.

Every visitor who comes to Allahabad enquires about the things this town is famous for. While one introduces Allahabad, one has to mention guavas or *Allahabadi amrud* along with important places like the Sangam (the confluence of the rivers Ganga and Jumna).

The guava is not an Indian plant. It is said that its native home is in tropical America. In Cuba and Hawaii it is found as a weed and in some other places it has run wild. Though the native home is in America, yet no great improvement has been made there and the guavas of that area are not famous. The guavas of Allahabad are famous for their quality throughout the world. They have a sweet smell, good size (½ lb. in weight), and a pleasant taste. Except the papaya, the guava gives the quickest returns after planting of any local fruit. It can grow on land which is too poor for the profitable production of mangoes, citrus, and other fruits.

In the United Provinces the guava is perhaps the most important fruit plant. It is one of the hardiest, and can resist great heat and a few degrees of frost. At present it has an area of about sixty thousand acres in the U. P., and therefore enjoys the first position in comparison with other fruit plants except the mango (and a considerable portion of the area under mangoes is non-productive).

Guava fruit is usually appreciated when eaten fresh. Some people like the fruit in a semi-ripe condition and others who cannot eat it in dessert form turn it into syrup and take it with cream. The fruit is also used for jelly making.

Locally the wood is generally burnt or sometimes used for petty purposes by the grower. The wood is compact, hard, close-grained and fairly strong. At Saharanpur fine carving work is being done with it, and beautiful patterns are being inscribed on the wood. The wood takes a beautiful polish. Small articles like pegs and tool handles are usually made.

The cultivation of the guava is not very difficult and it grows even in hilly areas. It has two fruiting seasons, *i.e.*, winter and the rainy season. The price of the fruit is not very high and therefore the guava is within the reach of the poor,

Only during the last war did the American people realise the importance of this fruit : they came to know its high vitamin C content. According to J. E. Coit, guavas have 4 to 10 times higher vitamin content than orange juice. The necessity of vitamin C for the body needs not to be emphasised here. Therefore it is a cheap source of vitamin C for the poor people of our province.

The guava, which is so important to our province, faces many horticultural problems common to all fruits, *i.e.*, propagational, irrigational and manurial. To tackle the above problems it is necessary that investigations should be carried on in different localities. Besides the above horticultural problems, that regarding the genetical improvement of the plant remains no less important. The genetical improvement of the plant is essential because the quality of the fruit is directly based on the genetical constitution of the plant. Therefore this problem requires immediate tackling.

During recent visits to local orchards, the author has in general, come across the complaint that the quality of the Allahabad guava is deteriorating. This naturally gives rise to the question why it is so. The answer appears to be the lack of proper knowledge among the growers. The trees planted are largely seedlings and show great variation. Therefore, any mass plantation of guavas without careful selection and vegetative propagation will lead no doubt to a larger acreage, but not to real improvement of the plant itself. It has been observed that sometimes different types of fruits, *e.g.*, smooth as well as warty ones are produced on the same branch of the plant. The causes of the production of such fruits is an interesting problem.

There is another problem which is drawing the attention of guava growers. Mass drying of guava plants in various localities of Allahabad is taking place. A similar condition has been studied by Lucknow University investigators, but no method of controlling the disease has been announced.

For the above problems it is very important that a detailed cytogenetical study be carried on. In England, continued cytogenetical researches on fruit plants particularly those belonging to the genera Fragaria, Rubus, and Prunus have thrown light on the origin and mechanism of reproduction of many of those fruits and have helped in the classification as well as in the evolution of new and superior varieties. The guava has similar problems ; hence a detailed cytogenetical study will lead to proper and real improvement.

Realizing the need of such an important study, cytogenetical studies on the guava have been started by the author in the Botany Department, University of Allahabad.

At present he is engaged with the collection of data about the various types of guavas in different places of India, as well as with the chromosomal studies of various types of guava which are locally grown.

Other studies such as the production of new plants by the use of hormones and colchicine, are also in progress. It is expected that after five or six years of such investigation on the guava, some real improvement can be attained which will really benefit the guava grower and the fruit industry particularly of the Allahabad district and the whole of India in general.

THE SCALE OF THE AGRICULTURAL UNIT*

By

John P. Maxton.

One of the first things taught to agricultural economists, when being initiated into this problem of the scale of the agricultural unit, is that the term "size" needs a lot of qualifications. They are warned that the number of acres by which the land is measured is not an infallible guide to the size of the business. The amount of capital, or of labour, or of skilled organization, may be in inverse proportion to the acreage.

We are warned to remember the difference in soil fertility, in accessibility to markets, in supplies of skilled or casual labour, in the general level of intelligence and education, in the availability of fresh land or so forth. All these in various ways, we are reminded, go to determine whether a farm of particular size—be it 10 acres or a 1,000—is large or small and acreage alone is an insufficient guide.

What we are faced with even in countries with a modern economy, is an infinite variety of sizes, some of which are capable of national explanation, some with no other justification than that they just happened that way at some date and have never changed. Or, if they have changed, their changes have been determined by chance circumstances more than deliberate thought.

In the studies of the financial returns of farming which agricultural economists have made—and these now cover, I should think millions of farms over many countries and many years—some attention has always been given to the comparative results on different sizes of farms. And yet if you took a representative sample of agricultural economists from a number of countries you would find that they were not unanimous even on the general principles of their verdict. Unanimity about the actual optimum size in acres of land could not, of course, be expected, not even if we made as good a classification of types as humanly possible. There might be definite agreement that certain sizes are too large and others too small but just what would be the dividing line between these I doubt if you would find any one daring enough to state.

Up to this point I have been talking of size as measured by the area of land, and after all farms usually have to have

* This article was taken from the report of the Rural Life Conference held at High Leigh in England. The article has been somewhat abbreviated for our readers by J. G. Short.

specified boundaries and a measurable area. Also in dealing with the inconclusiveness of the evidence about one size being more efficient than another I have been talking of the best of book-keeping showing in financial terms what return the farm has yielded in the year to its operator. That does not necessarily mean only the monetary return. It is an attempt to translate all the *material* returns to the operator and his family in so far as they are translatable (and are successfully translated) into financial terms. And the material net proceeds for this effort are a primary consideration for any farmer.

It is time for me to introduce an aspect of the question where there is perhaps as much disagreement, but where the lines of disagreement are much more clearly marked. I believe it is true to say that the very acute controversy which chronically exists over the scale of the agricultural unit does not arise primarily on size at all. It arises on something that is more fundamental than the counting of acres or the measure of profits.

What is this fundamental "it"? Eastern Europe thinks of a unit of some 10 to 25 acres; and Denmark one of, say 40—60 acres; Americans are not excluding farms of over 1,200 acres. And all with complete unanimity and, strange to say, complete consistency uphold the small or medium farm and condemn utterly the idea of farming in large units. What they defend after all *is not size as such* but a *structure which sets limits to size.* The limit of size might differ according to conditions, but on the maintenance of the *structure* they are unanimous—and one must add, adamant.

This structure I shall refer to as the peasant-type structure. I use that ponderous phrase because Americans and Canadians and no doubt other countries which consider themselves modern, resent being called peasants, and, of course, a middle-west farmer has little in common either in techniques or outlook, or standard of living with the peasants of Eastern Poland or Southern Italy. But in the essentials to which I refer, the peasant holding is the same as the family farm which is the term our American countries prefer. Perhaps I ought to say, that is the *ideal* which is the same in both cases, because in practice everywhere, even where it is the ideal, many farmers do not achieve it.

The ideal structure which is so widely upheld *is one in which the individual farmer combines in himself the roles of landowner, capitalist, farm worker, and farm manager—all the factors of production united in the farmer himself,* so

that in practice he is neither landowner, capitalist, labourer or manager but a peasant, a "bauer", a family farmer, a yeoman. The fact that he is to be all of these, clearly limits the scale of his operations: where land is scarce he cannot own much land, or it may be that his capital is too small, or, especially when he is poor and his technique and capital are primitive, he cannot work more than a small area. Thus at one end the limit set may be a very few acres, while on a wheat-growing area of the U. S. A. where land is more accessible, though no longer free, with plentiful capital, machinery and modern technique, one man and his family may own, capitalize, and manage with their own labour a farm of as much as 1,200 acres. But the essentials of the structure are the same, and these are what the economists unite defend.

One of the features of industrialism has been to differentiate functions, to organize an undertaking with capital which is almost certainly not one's own, on land which may belong to someone else, and to employ wage-earners for labour. British farming has gone just a little way in that direction, not by any means as far as one might have expected in so industrialized a country, but far enough to make foreign agrarians believe that we are lost from the true faith and therefore damned. As I shall keep emphasizing, this belief in the peasant-type structure is so universal, so fundamental—to our colleagues abroad almost axiomatic—that we must understand its essentials.

It would be easy to confuse the peasant-type structure and therefore, the whole issue with a self-sufficient economy. It is very common for folks to believe that peasant farming means self-sufficient farming; that is producing primarily for one's own household. You will find Americans and Canadians who declare that their farming is not peasant farming because it produces for the market and not for self-sufficiency. One only has to remember Denmark and Holland among the modern peasant countries to appreciate that peasant economy and self-sufficiency need not be synonymous.

But the peasant-type structure does have its origin in self-sufficiency not only in the old civilizations but even in the new. This origin in self-sufficiency of the family farm of the peasant farm, or, to use the phrase I concocted to cover both, the peasant-type structure—is a point to bear in mind.

I shall be comparatively brief in outlining the case which is put forward for this peasant-type structure, by using three generalizations.

First: it is claimed that it gives the optimum of good technical working—not necessarily the best in terms of efficiency that might be got in some circumstances by other systems, but the best all-round in all the varying circumstances with which farming has to contend. The basic reason behind this is that soil and stock need a personal care amounting to affection, and, it is argued, you can only get that in true measure from this highly personal type of structure.

Second: it is claimed that it provides the stability and independence of economic existence which, in turn, are essential: (*a*) to good long-term farming (*b*) to the best kind of life for the cultivator himself; and (*c*) to an economic stabilizer for the community and the nation as a whole. The claim is that the peasant-type structure is somehow independent of the vagaries of the money economy which are the curse of modern industry and trade, the speculation, the uncertainty, the dishonesty of money-grabbing. Agriculture might be at the mercy of God and nature, but, thank the Lord, it was a life free from the evils that man had created for himself in industry and trade.

Third: it is claimed that it is a life favourable to the simple virtues, and that for this reason, in the aggregate, a peasantry is an influence which nation can do without if it is to be a sound, unaggressive democracy. In argument, all these three claims get mixed, expecially the second and third.

On the argument for the virtuous life, I am going to leave you to express your own opinion. My experience is that most people at times have this nostalgia for the simple life, although, as Dr. J. F. Duncan delights to point out, most of us have left it when we had the chance and in practice few ever return in their working life. Whether that is a condemnation of the way of life or of human frailty and the failure to pursue the virtuous path, I shall not say. The argument about independence is, I feel, very deceptive in modern times. It rests on an assumption that the peasant-type economy is substantially independent of the money economy which dominates industry and trade. That seems to be harking back to a belief in a self-sufficiency economy, which has ceased to exist in developed countries and which, if it did exist, would not provide that well-rounded standard of life—however simple—which the peasant type economy is claimed to provide in good measure. It is doubtful if this claim to substantial independence is so very well founded. It looked true so long as the general economy was moderately

healthy—without necessarily being unduly prosperous—because the dependence of the peasant on the general economy was not thrust into prominence. In those conditions peasant agriculture could put up a resistance to the forces of the general economy and survive. But when the general economy was hit by a slump, all countries, including those most conspicously organized on peasant lines, were seen to find it desperately necessary to adopt every device of protection for the benefit of their farmers. That does not sound like an automatic independence of the general economy.

But if it were true that the peasant economy is largely independent of the general economy, is it a wholly desirable situation in a modern society? Is it not essential that the forces which adjust a community's economy should bear upon those who conduct its agriculture as well as on industry and trade? These are questions which require discussion.

But although it is at least arguable that the disorders of the general economy were a test of peasant independence which it didn't pass, it did not alter the conviction of foreign agrarians. In some quarters, it strengthened it.

I have dealt on this issue of the peasant-type structure and have put its case as fairly as I could because it is so enormously important. It is deeply embeded in the faith of such an overwhelming proportion of the world that it is inescapable. It is something that must be taken for granted nearly everywhere, and it would take a revolution greater perhaps than any we have had, to alter it within a generation at least.

As a word of caution, note that I am not saying that we could not do without the peasant-type structure. It is at least arguable that technically, economically and socially we could. What is inescapable is the profound faith amongst agrarians in most countries in this peasant-type structure. If it were not for this dominating factor we would expect a strong movement towards an industrialized form, large units which permitted the employment and organized use of numbers of skilled wage-paid labour; which could utilize machinery and specialized capital in other forms to the maximum efficiency; which could use highly qualified scientists; which could get the benefits of large-scale buying and selling and processing for market.

There has always been a good deal of exaggeration about the advocacy of large units, which has rather laid it open to

ridicule. The picture of the very large farm run on highly industrialized lines gives the practical farming man a sense of unreality. No one has ever analysed satisfactorily—in contrast to the peasant-type structure—what are the features of the industrialized alternative which are compatible with good modern farming. Farming is an intimate business. It needs intimate decisions which cannot be postponed for reference to a board meeting, or to Whitehall, or even to a busy managing director who has other things to do. There is an intimate personal something in farm management, although it is nothing like so intimate that it is lost if a farm gets bigger than five acres, one cow, two pigs and a dozen hens. It may, however, be lost when the undertaking gets so big that the manager loses close personal touch with all that is going on. In practice that point may be reached somewhere over 10,000 acres, and the number of farms of that size is very small. Where the exaggeration comes in is when we realize that to make all farms even 500 acres—which is a long way short of 10,000, but which is big enough to give some advance in obtaining the advantages of size—would mean a great agricultural upheaval even in this country of comparatively large farms. In England and Wales by that step (*i.e.*, making all farms 500 acres) the number of holdings would have to be reduced from 384,000 to some 50,000 There would be some argument about that.

In conformity with what I said earlier, the alternative to the peasant-type structure is not size as such, but a form of organization. The essentials have not been satisfactorily analysed, but in the main they turn on the ability to divorce the various functions from one another, so that land, labour, capital, and management can each be handled in its most efficient way. That all too brief definition must serve on this occasion.

I revert to the point that throughout a large part of the world we have to proceed on the assumption of the peasant-type structure. It does not mean that the believers in this system are satisfied (*a*) that all peasant farms are big enough (*b*) that they must be unprogressive in technique. Very far from it. In most countries, it is generally admitted that for modern progress most farms are too small, and in some countries a disastrously large proportion are totally inadequate to give a man even a bare living. In Europe agrarians are greatly exercised over certain large problems of policy which are very closely bound up with this subject and the solution of which would enable agriculture to make considerable technical and economic progress.

I have time only to headline three of the most important: (1) Pressure of population trying to make a living from the land is only too well known. (2) Too many too small farms, which arise partly from the pressure of population, partly from inheritance laws, and always through lack of alternative means of livelihood. (3) Splintered holdings, where any one farm, consists of several little patches of land scattered over the surrounding countryside. The extent of this is often unbelievable. May I quote from a paper by Dr. A. Munziger on the "Co-operative Machinery Employment by Peasant Farmers" (Proceedings of International Conference of Agricultural Economists: Third Conference, 1934, O. U. P., London, pp. 237-8) Referring to a farm which he examined in Wurttemberg, a farm of 75 acres, which was large for that region; he says:—

> "The number of its plots is 162. The average size of a plot is 2,248 sq. yds. The size of the smallest is 87 sq. yds., the largest 14,880 sq. yds. The total distance of all the plots from the house amounts to 120 miles. If the peasant had the idea of going from his house to every plot and back he would have to cover 240 miles. Of course, he doesn't want to...... Yet these figures show what waste of time such splitting up of the peasant property accounts for and how considerably it must reduce the success of the work of the peasant family."

To consolidate these plots would seem a simple enough proposition but in practice nothing engenders more opposition or more heated controversy. Recently we were told that in some villages in Switzerland where the peasants came together to discuss redistribution of plots for the purpose of consolidation, it had been necessay to adjourn the meetings to the churches, for only by doing so could the temper be kept within bounds.

When one comes to deal with such problems or with less complex ones, such as the use of modern machinery and so on, every solution is conditioned by the assumption of the maintenance of the peasant-type structure. Whether good or bad, it forces agriculture to seek the benefits of a large-scale organization by all kinds of devices of co-operation, not only in credit, processing and marketing with which we have long been familiar, but in all sorts of new directions. There may also be considerable development of supplementary state institutions—of the tractor station, machinery pool, capital con-

struction type. There will also be much that is of the purely regulative type of institution. All or nearly all of these are devices made necessary because agriculture itself is not industrialized. This part of my subject is being skimmed with scandalous brevity, but I am mentioning it so that it may not be neglected in discussion.

May I just wind up, in so far as a talk of this kind can ever be wound up, in this way:—

Some of you are concerned with areas and conditions where the developments is far behind even the low minimum at which my academic approach starts. But ultimately you have this issue to face whenever some modern progress is attempted.

Put it in these questions —

(1) Have we to accept this faith in the peasant-type structure as inevitable, and make the best of it by one device or another ?

(2) Should we fight it and hope to persuade agrarians to take a freer, more industrialized attitude towards the land and farming ?

(3) Should we try to side-step it in the hope that time and circumstances will alter things, particularly in the hope that a growth of industry drawing off population from the land to produce an ever-increasing quantity of goods and services for higher standards of living, will tend ultimately to the abandonment of the peasant idea ?

(4) Or—and some of you will wish to put this right up in the front—do we believe that the faith in the peasant-type structure is right and, therefore, should be preserved almost at all costs ?

But—and this is the central purpose of my paper—we should be clear about what it is we are pinning our faith to. It is not size as such ; it is not self-sufficiency ; it is not a nostalgia for some golden age when men lived nearer to a state of nature. It is relatively easy to form a modern opinion on any of these.

It is a type or organization, a way of holding land, and property ; of rewarding toil ; of applying capital, all in one. That is what we have to make up our minds about and it is not so easy.

BACK-CROSS METHOD IN PLANT BREEDING*

By

R. S. Roy, B.Sc. (BHU), M. Sc. (Calif.), AMSS (USA)

Horticulturist to the Government of Bihar.

Introduction :—

Considerable work has been done in the field of evolution of strains of different crops by the common methods of selection and hybridization with appreciable success, but the progress in this direction has been remarkably advanced by application of the recent back-crossing method. Harlan and Pope (1922)† pointed out its probable value in small grain breeding, and stated that it has been largely, if not entirely, neglected in any definite breeding programs to produce progeny of specific types. They suggested the probability that there were many instances in which back-crossing would be of greater value than the more common method of selecting during the segregating generations after making crosses.

One of the ways in which back-crossing is particularly valuable is in adding disease resistance to a variety that is commercially desirable in all other respects.

Review of Literature :—

Briggs (1938)[1] suggested that the back-cross, most useful in the transfer of specific characters, such as resistance to diseases and insects, is based on the simple fact that heterozygous population back-crossed to either homozygous parent would become homozygous for the genotype of the recurrent parent. The proportion of homozygous individuals in any back-cross generation is the same as would result from an equal number of selfed generations and may be expressed by the following well-known equation :

Proportion of homozygosity $= \frac{(2M-1)}{2M}n$ where "n" is the number of pairs of heterozygous factors and "M" is the number of generations of selfing or back-crossing, as the case may be.

Richey (1927)[12] has given the percentage of plants homozygous for "n" factors entering the cross only from the recurring homozygous parent in each of "r", successive generations cal ulated from the above formula.

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*Term paper for the M.Sc, degree in the University of California, Davis, U.S.A.

† Figure indicates literature cited.

TABLE I

Percentages of plants homozygous for "n" factors entering a cross only from the Homozygous Recurrent Parent (from Richey).

Number of factor pairs n	Number of generations of back-pollinating, r									
	1	2	3	4	5	6	7	8	9	10
1	50	75	88	94	97	98	99	100	100	100
5	3	24	51	72	85	92	96	98	99	100
10	..	6	26	52	73	85	92	96	98	99
15	..	1	13	38	62	79	89	94	97	99
20	..	..	7	28	53	73	85	92	96	98
30	..	..	2	14	39	62	79	89	94	97
40	..	..	..	8	28	53	73	86	92	96
50	..	..	..	4	20	46	68	82	91	95
75	..	..	..	..	9	31	56	75	86	93
100	..	..	..	..	4	21	46	68	82	91

Richey (1927)[12], also gave a summary of the number of plants required in F_2 and the first back-cross generation to obtain a single individual with the required genotype when one to eight factors were involved. Those which are calculated on the basis of independent inheritance are given below :—

TABLE II

Progeny required to have one Dominant Homozygous Individual (from Hayes and Immer).

Method	Number of factor pairs							
	1	2	3	4	5	6	7	8
F_1 Selfed ..	4	16	64	256	11,024	4,096	16,384	665,536
F_1 back-crossed to homozygous dominant.	2	4	8	16	32	64	128	256

The above table clearly shows that with the difference of five factor pairs in the parents the calculated expectation in F_2 is only one individual out of every 1,024 with all 5 factor pairs in a dominant homozygous condition, whereas for the first back-cross generation, the theoretical expectation is one out of every 32 that contain all 5 factor pairs in a dominant homozygous condition. If more factors, say 20, are involved in a breeding program, the problem becomes complicated, but if these 20 factor pairs are inherited independently in a back-crossing program, there is a rapid elimination of those characters coming from the non-recurrent parent except the desired one or two characters for which the non-recurrent parent has been used in the program under question. With each re-cross the genotype of the non-recurrent parent is reduced to one-half for characters like shape and size of the seed color and other undesirable characters. Thus in five back-crosses only 1/64 of the genotype does not possess the character of the recurrent parent of commerce which has retained by selection at the same time, the important desirable characters of the non-recurrent parent with which it was crossed in the beginning.

Briggs (1938)[1] assumed 21 factor pairs governing yield, quality, adaptation, own character and resistance to stem rust in the cross, Hope and White Federation wheats. In F_2 of such a cross the White Federation genotype would occur only once in 4,398,046,511,104 individuals and to grow such a population would require over 50,000,000 acres of land which is about the area normally planted to wheat in the U.S.A. This is really a complicated problem to be solved by segregation program where there would be 2,097,152 homozygous genotypes which are all different. If the above hybrids are inbred for 5 generations, approximately half of the population will be homozygous and equally divided among the genotypes mentioned above. If, instead, back-crossing is practised and 5 back-crosses are used, the same recurrent parent will be present. This is a great advantage to plant breeders.

The frequency at which the successive back-crosses may be made will depend on the ease with which the character to be transferred can be followed in hybrid population. In many cases considerable progress can be made by selections at the end of the first back-cross. After the third or fourth back-cross, the material is so nearly like the recurrent parent that selection for characters other than the one being transferred is not very effective.

Much has been and can be accomplished in the direction of evolving disease and insect resistant varieties by back-crossing program. This method is admirably suited for such improvement. Even the characters such as yield or quality can be improved to a great extent if one parent of the hybrid is more desirable commercially than the other.

It will also be necessary to consider the question of linkage in back-cross method of breeding. Linkage between favourable factors would be beneficial to the program of improvement, and especially when it is known, larger population should be grown. Success in obtaining any desired combination would be inhibited only if the factors concerned were linked so closely that no crossovers could be obtained. This would be equally inhibitive under any other method of breeding but any given linkage would interfere less under back pollinating than under selection within selfed lines.

EXAMPLE OF A BACK-CROSS—

Specific plan for using back-cross on one crop, as an example of the method.

(a) *Review of literature on Blackeye (cowpea) improvement on Fusarium wild.*

The project of improvement of wilt resistant Blackeye beans (cowpea) in California has been cited as an example in this paper. Cowpeas are called peas in the southern United States. In California the one type grown is known as the Blackeye bean. In the southern U.S.A., where cowpeas are more generally cultivated than elsewhere they are used as snap bean pods, green shelled peas, dry beans and also as forage and covercrops. With the increase of Blackeye production in California, diseases to which the beans are susceptible begun to appear. The most destructive and virulent was Cowpea wilt, caused by the fungus strain Fusarium *Oxysporium f. tracheiphilum* which is specific to cowpea only. Other diseases such as root-knot nematode and Sclerotium rot are also quite common. Sometimes the wilt attack has been so severe in California that entire fields have wilted after some period.

In 1929 Professor Mackie was assigned the task of breeding Blackeye beans resistant to this destructive disease and he came to the rescue of farmers with the wilt-resistant variety, Blackeye 5.

In his breeding work he used Iron Cowpea as the resistant parent after testing for resistant stocks in the nursery. The

Iron Cowpea is unlike the Blackeye in many characters. It is a bit late in maturity, unusually viny and has a very hard small brown seed unfit for human consumption. Blackeye is early in maturity, and yields a high crop of very large white coated seeds with blackeyes, quite suited for human consumption.

Mackie (1946) [11] made crosses between Old Blackeye and Iron and tested the F_1 and succeeding generations in a heavily infected sick soil. He used Blackeye as the female parent. He followed the method of back-crossing F_1 to California Blackeye. He continued back-crossing to the fourth and sixth generations and carried further only those crosses made on disease resistant plants. The F_1 was black, showing dominance over brown seed color of Iron, but the desirable seed coat character of Blackeye was restored after back-crossing and rigid selection. The viny character was domniant and so it was easy to fix the oval, upright types of Blackeye as it was recessive. He also selected some viny types for forage or covercrop varieties. Disease resistance was found to be dominant over susceptibility. The number of factors involved in disease resistance could not be determined as many diseases were involved. Thus beginning with the fourth and sixth back-crosses, thousands of disease resistant selections were tested under severe disease attack in the plant-to-row plots. The best of these were increased and placed with bean farmers. These first distributions were not fixed in all characters, but further selections involving hundreds of plants from each strain were tested. These tests resulted in varieties much improved in resistance to disease attack especially wilt, and thus the Blackeye 5 originated.

Kendrick (1931 and 1936) [5 & 6] worked on Fusarium wilt resistance. He found out from field trials in 1928-29, that Virginia Blackeye cowpea was highly resistant to wilt, but not adapted to California cultural practices. Hybrids from crosses between the California and the Virginia blackeyes were highly resistant, but tended towards extreme vegetative vigor, irregular and light seed production and somewhat small seed. Repeated planting on sick soil, extensive single plant selections and back-crossing to the susceptible California Blackeye resulted in several strains highly resistant to both Fusarium wilt and root-knot with increased production and less vigorous vines of commercially desirable seed types.

(*b*) *Short description of Fusarium wilt organism.*

A short description of the attack of the organism will be of interest. The wilt of Cowpea (*Vigna sinensis*) caused by

Fusarium Oxysporium f. tracheiphilum is a serious factor in nearly all the sections of California where Blackeyes are grown. In many cases the soil has become so thoroughly infested with the wilt that the growing of Blackeye is no longer profitable. The increasing severity of the disease has forced some growers to use new areas for growing Blackeyes in California.

Orton (1902 and 1909) [7 & 8] said that the Cowpea wilt does not appear until the plants are about six weeks old. At first a few plants are noticed throughout the field with pale green flaccid leaves, which soon turn yellow and drop from the plant. The plants showing the disease early in the season usually die prematurely and fail to mature seed. As the season advances, more and more plants show the disease as evidenced by their dwarfed condition, yellowness, and in many cases death of the infected plants. When the stems of such plants sre examined more carefully the vascular system shows a dark-brown mass of disintegrated tissue with only the outer cortical area showing evidence of life. The vascular discoloration often extends throughout the plant. Since many diseased plants mature seed, the possibility that the fungus responsible for the disease might be carried with seed is likely.

Generally the fungus enters the plant from the soil through the smaller roots and grows through the water ducts of the skin, until it may be found in advanced cases, even a smaller branches and petioles of the leaves. The mycelium is nearly white, but it causes the walls of the vessel to become deeply stained. Some of the vessels of the plant are completely filled with interwoven hyphae of the fungus and the supply of water and plant food carried from the roots to the leaves is greatly diminished. The appearance of the plant affected by the disease indicates that it is suffering from lack of water. The diseased areas in the fields increase in size quite rapidly by direct growth from the edges which is due to the spread of the mycelium through the soil.

The degree to which disease resistance is inherited is naturally a matter of fundamental importance to the plant breeder. Disease resistance is a protective quality developed by the species as a result of the struggle for existence with the parasite. The chances for success in breeding for disease resistance will, therefore, be seen to depend on the nature of the parasite, its degree of adaptation to the host species, the length of time it has been prevalent and the possibility of crossing the host with related resistant forms. Breeding for

disease resistant varieties, therefore, cannot be considered as permanent when a resistant variety is secured. Not only is the variety itself subject to variation through mutation and field hybridization, but the disease itself is subject to the same variations (Mackie and Smith, 1935) [10].

Similar things happened to Blackeye 5 evolved by Mackie which did very well for several years. Lately, however, Blackeye 5 has shown some susceptibility evidently to a new race of the wilt organism (Fusarium). Iron cowpea is still highly resistant to the Fusarium wilt and other diseases. So a breeding program has been formulated at the Agricultural Experiment Station, Davis, in 1946 to Improve Old Blackeye and Blackeye 5 by following the back-cross method to obtain greater resistance in Blackeyes. The work is under progress at the Experiment Station since 1940, according to the program described in this paper.

(c) *Detailed plan of improvement.*

Plan of improvement by back-cross method of Blackeye is outlined as below:

Selection of parents for crossing.—A variety of Blackeye (A) with desirable characters but lacking in one character of disease resistance. The variety Iron (B) containing the high of degree disease resistance which the Blackeyes lack.

Selection in the selfed progeny from plants carrying the factors obtained from Iron, *i.e.*, disease resistance, until homozygosis for this character is obtained. In the case of self-pollinated crop such as Blackeye, the new lines obtained, may be compared with each other and with Blackeyes in field trials. The strains of greatest promise may be increased and distributed as improved varieties if their performance is satisfactory.

The first cross was made in 1946 between (I) Blackeye 5 X Iron curd (II) Old Blackeye X Iron. The F_1 has been grown in 1947 and the resistance to wilt disease has been found to be partially dominant in both crosses. The crossing with Old Blackeye has been done to study the comparative degree of resistance of Blackeye 5. The F_2 seeds are in both cases unicolored black. Back-crossing F_1 plants to both Blackeye 5 and Old Blackeye has been done this year for further selection to obtain the desirable plant and seed characters of Blackeye of commerce while rigid selection will retain the disease

resistance of the Iron cowpea. The following details of plan may be followed in this improvement program :—

1946, 1st year—Parents-Blackeye 5 and Old Blackeye (commercial but susceptible varieties) X Iron cowpea (wilt-resistant).

1947, 2nd year—BC_1 —F_1 (resistant progeny) (self-coloured-black) X Blackeye 5 or Old Blackeye.

1948, 3rd year—Back-crossed plants segregate resistant : susceptible. The selfed F_1 segregate into many colored types of beans. The back-crossed plants segregate into 1 self colored : 1 white seed coat with blackeyes. Self colored types will be rejected as they are not desirable. Only the Blackeye types which are resistant will be kept. From known color factors, it can be predicted that for color there will be 4 types in equal number: 1 RBWH black self: 1 RBWh black holstain eye: 1 RBwh black watson eye: 1 Rbwh black sm all eye. These last will segregate 1 buff and black and red: 1 buff and black: 2 true breeding small blackeye. The F_2 will have 3/64 with small blackeye. There will be 64 buff and 16 red which can be eliminated as not carrying *B*. The BC_1 seeds should be grown in severely infected sick soil of Fusarium wilt disease so that easy way to the rejection of susceptible types can be practised. The other way will be to test these seeds in a green house and cause artificial epidemic of the disease by inoculation of Fusarium culture. Fusarium organism is easy to culture and, therefore, epidemic can be effected easily. Thus the really resistant plants containing resistant genes can be selected.

1949, 4th year—Plants may segregate 3 resistant: 1 susceptible. Resistant plants should be again inbred and back-crossed to the recurring parent.

1950, 5th year—Resistant parents would segregate giving one homozygous and two heterozygous rows. Further back-crossing to the recurrent parent

(Blackeye 5 and Old Blackeye) can be made if all the desired characters have not been obtained. Selection for the desired commercial characters should be made simultaneously in all the selfed generation.

1951, 6th year—BC_3 F_1 X Blackeye. In this way 4 or 5 back-crosses would be sufficient to obtain the resistant type with other desirable characters. Selection should always be practised under suitable disease epiphytotics so that really resistant plants can be selected.

Thus back-crossing should be followed by selfing for some generations in order to get the factors for resistance into the homozygous condition. Secondly it affords all opportunity to select the most desirable lines for further back-crossing.

SUMMARY.

Back-crossing method of breeding is becoming very popular with plant breeders because the undesirable factors are eliminated easily.

There is more chance of getting success in a back-cross process than in a simple hybridization program. The reason is based on a simple fact that heterozygous population back-crossed to either homozygous parent would become homozygous for the recurrent parent.

It is gaining ground particularly in developing disease resistant varieties of crops. Blackeye 5, a wilt resistant type, was evolved as a result of this method but after a few years the disease began to appear again, probably due to some new form of Fusarium wilt organism. Further improvement of Blackeye has been planned and started at the Agricultural Experiment Station, Davis, California as outlined in this paper.

ACKNOWLEDGMENT.

The writer is thankful to Dr. F. L. Smith and Dr. Catherine B. Madson of the Division of Agronomy, Davis, for their able guidance in writing this paper.

ITERATURE CITED.

1. Briggs, F. N. (1938). The use of the back-cross in crop improvement. Amer. Naturalist, Vol. LXXII, pp. 285—292.

2. Harlan, H. V. and M. N. Pope (1922). Journal of Heredity 13; p. 319.

3. Hayes and Immer (1942). Methods of Plant Breeding. McGraw-Hill Book Co., New York and London.

4. Jones, D. F. (1942). Proceedings Nat. Acad. Science ; 28, pp. 38—49.

5. Kendrick, J. B. (1931.) Seed transmission of cowpea Fusarium wilt. Phytopathology 21 ; pp. 979—83.

6. Kendrick, J. B. (1936). A cowpea resistant to Fusarium wilt and nematode root-knot. Phytopathology 26 ; p. 98.

7. Orton, W. A. (1902). The wilt disease of cowpea and its control. U. S. Bur. Plant Indust. Bul. 17 ; (Pt. I) pp. 9—22.

8. Orton, W. A. (1908). The development of farm crops resistant to disease. U. S. Dept. Agr. Yearbook 1908 ; pp. 453—64.

9. Orton, W. A. (1911). The development of disease resistant varieties of plants. Intert. Conf-de-Guetiguey, pp. 247—61.

10. Mackie, W. W. and Smith, F. L. (1935). Evidence of field hybridization in beans. Amer. Soc. Agron. Journal 27 ; pp. 903-909.

11. Mackie, W. W. (1946). Blackeye Beans in California. Bul. No. 696, University of California, College of Agriculture, Berkeley.

12. Richey, F. D. (1927). Amer. Nat. 61 ; pp. 430—449.

13. Richey, F. D. (1946). Jour. Amer. Society of Agron. 38 ; pp. 833—841.

THE FOUNDER'S DAY.

On Thursday, October 27th, the Allahabad Agricultural Institute celebrated Founder's Day. As a part of the celebrations a Christian Service of Thanksgiving and Prayer took place early in the morning at the end of the bund overlooking the river Jumna. There follow two extracts of the Service, the Call to Worship, and the Address, by the Reverend C. Murray Rogers.

The Call to Worship—

Friends, we are gathered here before God, our Father, and in the presence of one another, to give thanks to Him through our Lord Jesus Christ for His great goodness to us, to thank Him for the founder of this Institute, for those of this and other lands whose gifts have made available to us a rich inheritance, and for the great privilege we have of living and working in this place. Above all, let us praise Him for His love shown forth to us and to all men everywhere in His gifts of creation and in the greatest of gifts, His Son, Jesus Christ, our Lord.

And as we meet to praise Him, so let us in sincerity and truth dedicate ourselves anew to God, our Father, that the common things of life and earth may once more shine with His Glory, and to Him be ascribed all might and dominion world without end. *Amen.*

The Address—

Psalm 107:43 : "Whoso is wise will ponder these things : and they shall understand the loving-kindness of the Lord."

Once in every year it is certainly very right that we should stop to celebrate, the founding of our college, to ponder for a short time what it stands for, and to thank God from the bottom for our hearts that he has called us to work and to prepare ourselves here for fuller service for God and for our fellow men.

Each day, and many times a day, we see people who have come from the ends of this land and beyond, we pass buildings that are here as the result of God's gift of a great vision to one of His servants, Sam Higginbottom. Less than 50 years ago you might have passed this way and seen only low lying uncultivated land ; today instead there stands a great institution with men and women in a thousand towns and villages thankful for what it stands for in their lives in terms of

growth and friendship. "Whoso is wise will ponder these things; and they shall understand the loving kindness of the Lord."

For it is the loving-kindness of the Lord which stands placarded before our eyes here. This is the work of God—be sure of that—and we are being thrown back on to the truth of that fact at this time.

Dr. Higginbottom saw that three great gifts had been committed to him by God, three great gifts of which he was to be a good steward. Let me put it this way—this Institute has a founder, and deeper, there are the fundamental principles upon which Sam Higginbottom founded this college of which you and I are members.

Those three gifts which make up the foundations are here today, the Earth, the Bible, and God's love for People. (See footnote).

The earth is the Lord's and the fulness thereof—but we men so often treat it as dead, as material to exploit, for some are selfish and others are ignorant. This Institute is here that once again men may know, through study and research, and in all humility, how to care best for God's earth, that it may in its fulness share its food, its bounty, with us men.

At the centre of this place, set here to study the earth and its resources, is the Bible. It was there in the mind of the founder, and has been there for countless others who have worked here.

The Bible, not as a dead book, but as a living Message about God, about His love for us men and women, of that love shown in Jesus Christ our Lord to His world. The Agricultural Institute is here to serve India, to serve Asia, to serve men and women of every creed and caste and race; it is here because Sam Higginbottom was certain that Jesus Christ was his Lord and Master. Those of us here today, who bear the name of Christ fail Him so often, our actions shout louder than our words, but put us aside, and the Christ of the Gospels, God who reveals Himself in the Bible, is the foundation of this college. Without it, without Him, you and I would not be here now.

NOTE—(See above): At the foot of the slope of the bund, facing the people was a type of all puna, a circular bed of earth decorated in Indian patterns with grains of wheat, rice and dals, and chains of flowers. The Bible lay open in the centre of the circle and the wooden Cross which was earlier in the procession, is stood behind.

The Earth, the Bible and People. Men and women, their worth as individuals, because of their worth in God's eyes, are the third foundation, represented by us who stand in the presence of God this morning. It is because God cares about you, about what you do with your life, that you are privileged to be here in the Institute. Men are not hands, men are not tools, men are the children of God, called to serve Him and their brothers.

The Earth, the Bible and People. Here are the foundations of this Institute. As you look at the buildings, as you work in the fields or workshop, as you eat and live together, remember from where you come, the heritage which you enjoy. "Whoso is wise will ponder these things; and they shall understand the loving-kindness of the Lord."

And as you pounder, as you see how far short we fall of these great facts on which our college stands, let us in sincerity and truth dedicate ourselves, our work, our courtesy, our service, our friendships, to the God without whose love we would not be here this day.

SOIL ACIDITY: ITS MEASUREMENT AND CORRECTION

By

ALLAH N. AGWAN,

B.Sc. (Ag.) Student, Allahabad Agricultural Institute.

Introduction—

The soil is a heterogenous mixture of matter in all forms, *i.e.*, solids, liquids, and gases. The mineral elements come from the decomposed rocks and are the product of many forces—physical, chemical and biological—which play their respective parts in soil formation, such as cold and heat, water, soil organisms, and gravity.

In this way the soil is a very complex matter containing organic and inorganic substances in varying quantities at different places. Chemical changes may make the soil acidic, neutral or alkaline.

A preponderance of hydrogen ions ($H+$) over hydroxyl ions ($OH-$) in the soil solution causes acidity, and the reaction is below p^H 7·0.

Soil reaction takes place in the soil which changes from one state to another. We can never keep the soil in any one condition as physical, chemical, and biological forces all act on it at the same time.

The following are the factors which are responsible for the formation of acidic soils :—

(1) The existence of free acids,

(2) The deficiency of basic substances in the soil,

and (3) The application of an excess of an acid fertilizer.

Acid soils occur most commonly in humid regions where rain water removes the basic substances such as calcium by drainage or percolation. This acid condition is sometimes found in arid regions where swampy conditions exist. This may also be produced by the removal of basic substances by plants. If continuous cropping is taken without the application of basic fertilizer or substances either organic or inorganic, after some time acid conditions will be produced in the soil.

If the toxic condition of the soil is due to an acid, there are a number of possible conditions such as the presence of (1) soluble organic acids in the soil such as cumarin, vanillin,

dihydroxy-stearic acid, alanine, and pyridine, (2) insoluble acids or acid salts which on contact with water produce acidity, and (3) soluble inorganic acids which may be absorbed by the soil complexes. The selective absorption of bases by the soil by which acidity may be produced from neutral or even alkaline salts, may also cause a toxic condition of the soil. Under certain circumstances aluminium may be an injurious factor in an acid soil. It is toxic when in concentration of as much as I5 p.p.m; and aluminium is often found in acid soils. Manganese and iron, in acid soils, are also toxic to plants.

In an acid soil two more or less distinct sets of hydrogen ions are involved : (1) those of the soil solution and (2) those held as absorbed cations by the colloidal complex. These groups tend to an equilibrium, are mutually supporting and alter the H-OH ratio of the soil solution.

The H-ion concentration of the soil solution is called actual acidity, and the H-ion concentration as absorbed cations by the colloidal complex is known as exchangeable or potential acidity.

Chief Characteristics of Acid Soils—

A very acid soil will present: (*a*) A low p^H, (*b*) Low exchangeable calcium and magnesium, (*c*) Soluble aluminium, iron, and manganese, (*d*) Possible organic toxins, (*e*) Low availability or lack of nitrogen and phosphorus.

p^H is the common logarithm of the reciprocal of the H-ion concentration expressed in gram per litre.

p^H value		Degree of acidity exceeding pure H_2O	Indication in Words
0	ACID SIDE	10,000,000	Extremely acid soil.
1		1,000,000	
2		100,000	
3		10,000	
4		1,000	
			—Very strongly acid.
5		100	—Strongly acid.
			—Medium acid.
6		10	—Slightly acid.

P^H value		Degree of acidity exceeding pure H_2O	Indication in Words
7	NEUTRAL	1	—Neutral.
8		10	—Slightly alkaline.
			—Meduim "
9	ALKALINE SIDE	100	—Strongly "
			—Very strongly alkaline.
10		1,000	Extremely alkaline.
11		10,000	
12		100,000	
13		1,000,000	
14		10,000,000	

Acidity Measurement—

The following are some of the methods used for measuring acidity in soils.

Rapid Colorimetric Method :—This is a fairly accurate method for testing soil acidity. The apparatus needed is the indicator solution and colour charts. The following are some of the procedures adopted :

(*a*) Place a pinch of soil in a spot-plate, moisten thoroughly with the solution provided, allow it to stand for a minute or two and then drain off a drop which is compared with the colour chart which will give the p^H measurement of acidity.

(*b*) Take the soil solution, put indicator in it and put the test-tube in the colorimeter. Compare the colour of the solution with that of the colour plate, which will give the approximate p^H, indicating whether it is acid or alkaline.

(*c*) Put a litmus paper into the soil-solution or into moist soil. If the colour remains blue, the soil is alkaline ; if it becomes red, the soil is acidic. The deepness of the red colour will indicate the degree of acidity. This is a very rough method of measurement.

Electrometric Method :— To determine the H-ion concentration of an unknown soil solution, a hydrogen electrode is immersed in the solution. The electro-motive force (E. M. F.)

of the soil solution may be determined and p^H can be obtained from the following equation by substituting the value of E. M. F. obtained at 25°C:

$$E = 0{\cdot}059 \log \frac{1}{p^H} + 0{\cdot}282 \text{ (constant).}$$

$$\frac{E - 0{\cdot}282}{0{\cdot}059} = p^H$$

This method is the most accurate but can only be carried out in the laboratory by soil scientists.

Crops Injured By Acid Soils—

Lucerne, *jowar* (sorghum), spinach, cabbage, cauliflower, carrots, onions, lettuce and muskmelons are very much injured by acidic soils; while wheat, barley, maize, oats, cowpeas, cucumbers, brinjals, pumpkins, radishes, soybeans, strawberries, watermelons, beans, tomatoes and turnips are moderately sensitive to acidity.

Potatoes, rice, sweet-potatoes, and castor-beans are not injured by soil acidity but, on the other hand, are benefitted by slight acidity.

Correction Of Soil Acidity—

We have seen above that different crops require different ranges of p^H. Some are acid-loving and some are alkali-loving crops. By correction of soil acidity, we mean to get the desired p^H in the soil according to the crops grown. If we have to grow alkali-loving plants such as lucerne, *jowar*, cauliflower, carrots, and onions and our soil is acidic, we have to raise the p^H of the soil to bring it to neutral or alkaline condition.

On the other hand, if we have to grow acid-loving crops such as potatoes, tomatoes, and sweet potatoes, and our soil is alkaline or slightly acidic, we have to lower the p^H according to our needs. As for example, potato requires p^H 5·3 to 5·4 and if we have the p^H 6·5 or 5·7 etc., we have to lower the p^H and if we have the p^H 3·4 or 3·9 in that case we are bound to raise the p^H to 5·3 to 5·4 because this particular p^H will give the highest yield under favourable climatic and soil conditions. This 5·3 to 5·4 p^H inhibits the potato-scab disease which is caused by Actinomyces.

Acidity may be increased by the application of gypsum (calcium sulphate), sulphur, iron sulphate, alum, acid organic matter, sawdust, moss, peat, etc. No definite recommendation can be made as to the amount of ferrous sulphate or gypsum

or sulphur that should be applied, since the buffering of soils and their original p^H are so variable.

The acidity of the soil may be lowered by liming or by the application of the alkaline fertilizers such as farmyard manure and sodium nitrate, or by stopping the supply of acidic manures such as ammonium sulphate or by applying basic substances.

Liming is the most satisfactory process for lowering the acidity of the soil. Forms of lime, that may be applied, are ground limestone ($Ca\ CO_3$) quick lime (CaO), and hydroxide of lime [$Ca\ (OH)_2$]. Calcium carbonate ($CaCO_3$) is usually applied to reduce the soil acidity but it has got a burning effect on the plants, so burnt lime is used which is better even than the ground or crushed limestone. Burnt limestone at the rate of 1000 to 4000 lbs. per acre or ground limestone at the rate of 2000 to 5000 lbs. per acre is applied to the soil and later assimilated with it by cultivating or harrowing at any convenient time.

$$\text{H—clay} + CaCO_3 \text{ or } Ca\ (HCO_3)_2 \rightarrow \text{Ca-clay} + H_2\ CO_3$$
$$H_2\ CO_3 \longrightarrow H_2\ O + CO_2 .$$

Calcium hydroxide is more active than calcium carbonate ($CaCO_3$) and, therefore it is used for quick effect. Calcium sulphate ($CaSO_4$) and calcium chloride ($CaCl_2$) are not recommended, though they contain calcium, because they leave strong acids in the soil which are harmful to the plants as indicated in the following reaction:

$$\text{H-clay} + CaCl_2 \rightleftarrows \text{Ca-clay} + \text{HEl}.$$

Hydrochloric acid is a strong acid.

$$\text{H-clay} + Ca\ SO_4 \rightleftarrows \text{ca-clay} + H_2\ SO_4 .$$

Sulphuric acid is a strong acid.

$Ca\ Si\ O_3$ is very costly and is generally not applied but if applied, the quantities are indicated as follows :—

Rate of application		Sandy Loam	Clay Loam
Moderate	..	1500—2000 lbs/acre	2000—2500 lbs/acre.
High	..	2000—2500 ,, / ,,	2500—2000 ,, / ,,

Magnesium limestone ($Mg\ CO_3$) is sometimes useful t
correct soil acidity.

Lime Reaction—

$$Ca\ CO_3 + Heat = Ca\ O + CO_2$$
$$Mg\ CO_3 + Heat = Mg\ O + CO_2$$
$$Ca\ O + H_2\ O = Ca\ (OH)_2$$
$$Ca\ (OH)_2 + H_2\ CO_3 = Ca\ CO_3 + 2H_2\ O$$
$$Ca\ CO_3 + H_2\ CO_3 = Ca\ (HCO_3)_2$$

Solution of lime in carbonate form

$$H\text{-clay} + Ca\ (HCO_3)_2 = Ca\text{-clay} + H_2\ CO_3$$
$$H_2\ CO_3 = H_2\ O + CO_2$$

Soil acidity is an acute problem in farming and shoul
be well understood.

References.

1. Farm science and Crop Production in India, by C. I
Dutt & B. M. Pugh.

2. The Nature and Properties of Soils, by T. Lyttleto
Lyon and Harry O. Buckman.

3. Plant Physiology Notes, by Edgar F. Vestal.

4. Manures and their application.
Industry Publishers, Ltd., Calcutta.

5. Private Notes by Dr. A. K. Dutt and Dr. B. B. Malve